Cooperation Centre for Scientific Research Relative to Tobacco

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Sustainability in Leaf Tobacco Production

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1. INTRODUCTION TO GUIDELINES

1.1 Context / Background

Tobacco is grown and processed around the world.

CORESTA members include equally diverse organizations, growers, universities, non-governmental organizations (NGOs), state monopolies, publicly listed companies, private companies, multinationals, local companies, and government agencies, most of them with many years of experience in addressing sustainability at local and global levels.

With this in mind, CORESTA launched a Task Force in 2012 to develop guidelines designed to capture the sustainable tobacco production practices implemented by its members, delivering the dimensions of environmental integrity, economic resilience, social wellbeing and governance. In January 2023, the Agro-Phyto Study Group was tasked to update this document.

These guidelines focus on four key areas:

- Governance
- Agronomy
- Curing
- Livelihoods

1.2 Objectives

1. To identify key challenges for sustainability in tobacco leaf production.
2. To review, update and complement CORESTA Guide No. 3, Good Agricultural Practices (GAP) Guidelines, considering sustainability Principles and/or Best Practice.
3. To identify tools to support the achievement of sustainability in tobacco production.

1.3 Scope

The scope of these guidelines covers sustainable tobacco production through the responsible management of tobacco growing.

Key challenges and opportunities have been identified in order to provide tobacco organizations with a set of tools and advice on how to address long-term sustainability in tobacco production.

a. **Governance**
The aim of these guidelines is to enable a common non-competitive approach to address four sustainability dimensions: governance structure, stakeholder engagement, farm performance and reporting benchmarks.

b. **Agronomy**
These guidelines address principles and sustainable practices applied to water resource management, soil conservation and health, plant nutrition, integrated pest and disease management and biodiversity.

c. **Curing**
These guidelines address various matters related to leaf curing, such as type and source of construction materials, fuel sources, fuel efficiency, management of the curing process and proper handling.

d. **Livelihoods**
These guidelines provide advice on practices that address relationships between farmers and purchasers, fair remuneration for growers and workers, capacity building, land tenure, health and safety and access to credit.

2. GOVERNANCE STRUCTURE

2.1 Context / Background

Depending on the context and the objective, in the domain of business, good governance is used to include: transparent and accountable processes, full respect for human rights, the rule of law, effective participation, multi-actor partnerships, legitimacy, access to knowledge, information and education, equity, sustainability, and attitudes and values that foster responsibility, solidarity and tolerance.

However, there is a significant degree of consensus that good governance relates to processes and outcomes that are necessary to achieve the goals of development. Good governance can be defined as the process whereby organizations conduct business, protect the environment, manage resources and guarantee the respect of human rights without abuse and corruption, and with due regard for the rule of law.

Good governance is linked to sustainable development, emphasizing principles such as accountability, transparency, responsibility, participation, environmental respect and protection of human rights, whilst driving sustainable economic and business growth for farmers, communities, companies, and all other key stakeholders.

Good governance and sustainable development are mutually reinforcing. Sustainability principles provide a set of values to guide the work of organizations and individuals. They also provide a set of performance standards against which everyone should be held accountable. Sustainability principles inform the content of good governance efforts: they may inform the development of policies, programmes, budgetary allocations and other measures.

Without good governance, sustainable economic and business development cannot be respected and protected in a sustainable manner. Good governance ensures the existence of a process to set objectives and assess results in accordance with the indication of stakeholders. The implementation of good agricultural practices, environmental protection and human rights policies relies in turn on a conducive and enabling environment. This includes appropriate managerial and administrative processes responsible for responding to the needs of the technical aspects of business and of stakeholders.

Organizations are encouraged to take steps that go beyond minimum legal requirements, where applicable. Thus ensuring that by pursuing crop production they do not infringe on the rights of farmers, workers and local communities, they comply with appropriate environmental, social, and human rights standards, they contribute to sustainable development outcomes and that they make pertinent information public and accessible.

The tobacco sector consists of various organizations whose structures range from limited to highly sophisticated systems. Size and market power also are very diverse.

Perceptions of the sector integrity are affected partly by how performance with respect to the economic, environmental and social dimensions of sustainability is communicated. Effective communication is based on the collection, evaluation and comprehensive compilation of performance data. Accounting complexity can be very high, particularly in diverse and internationally operating corporations. Reporting should be relevant and responding to the interests of the concerned audience.

2.2 Guidelines

These guidelines aim to support companies to put in place a robust governance structure mutually enforcing sustainable development.

Key attributes of good governance are:

1. compliance
2. transparency
3. responsibility
4. accountability
5. participation
6. responsiveness to the needs of the stakeholders

Bearing this in mind, tobacco organizations are recommended to:

a. have an explicitly and publicly stated business purpose, as well as a Code of Conduct, both of which are binding for management and employees, and values and ethical guidelines which are in line with the rule of law and the principles of the Sustainable Development Goals;

b. follow due diligence procedures prior to decisions with potential major and long-term sustainability impact;

c. ensure compliance to local and international legislation at all levels of the organization and formalize such requirement with farmers and suppliers through appropriate contracts;

d. set relevant, time-bound and measurable short- and long-term objectives in line with the expectations of stakeholders and make the results accessible to the affected stakeholders in a transparent manner;

e. regularly review all sustainability-related business areas and performance indicators in accordance with recognised sustainability reporting systems. Indicators should elicit comparable information on economic, environmental and social performance of the organization;

f. define, and wherever possible include in their scope of action all entities that generate significant sustainability impacts (actual and potential); subsequently report back to the public on sustainability issues, efforts and results;

g. disclose how management approaches a given set of topics in order to provide context for understanding performance in a given area;

h. align business behaviour with corporate ethics and review and assess it at the most senior level of the enterprise.

In addition, manufacturers are encouraged to:

a. Commit to procure only from suppliers that demonstrate commitment to and continuous improvement on sustainability performance;

b. Ensure that the terms of agreements with their suppliers such as prices, lead times and quantities are consistent with the suppliers' commitment to resources to fulfil the CORESTA sustainability guidelines;

c. Align sustainability principles with company organization interfacing with suppliers and farmers (including buying/procurement staff, legal departments, technical support and other personnel whose decisions may affect working conditions, labour practices and the environment in tobacco production). They should be provided with training and guidelines that enable them to carry out the company's sustainability policies and their performance should be assessed and managed accordingly;

d. Ensure that governance systems contemplate the cost and investment required to deliver sustainability when negotiating production costs and prices with stakeholders;

e. Integrate implementation and independent verification of the CORESTA sustainability guidelines as a positive performance measure when assessing supplier performance.

2.3 Suggested Indicators

a. Existence of a publicly accessible mission statement including social, economic and environmental objectives of the enterprise and existence of a Code of Conduct providing guidance concerning rules, information flow, sanctions and other important sustainability issues of the organization.

b. Existence of procedures and instruments such as risk management, environmental impact assessment to identify and address sustainability challenges within sector and supply chain, in compliance with agreed international standards.

c. Existence of due diligence, risk assessment or impact assessment concerning decisions on economic, environmental, social and governance issues, and the results shared with affected stakeholders.

d. Existence of regular, timely, correct and adequate communication with all stakeholders affected by operations.

e. Existence of valid, auditable information about economic, social and environmental performance (e.g. Corporate Sustainability, ESG, etc.).

f. Existence of transparent definitions of mandates, responsibilities and accountability concerning sustainable development at all levels of management.

g. Existence of procedures and instruments to evaluate the Code of Conduct and improve its implementation, including acting upon deviations.

h. Repeated failures on stated policy.

2.4 Additional Information

1. Food and Agriculture Organization of the United Nations (FAO) – Sustainability Assessment of Food and Agricultural Systems (SAFA) Guidelines
2. Global Reporting Initiative – G4 Sustainability Reporting Guidelines
3. Organization for Economic Cooperation and Development-Food and Agriculture Organization of the United Nations (OECD-FAO) Guidance for Responsible Agriculture Supply Chains
4. The International Standards Organization (ISO) 26000: Guidance on Social Responsibility and OECD Guidelines for Multinational Enterprises
5. United Nations: Guiding Principles on Business and Human Rights

3. SUSTAINABILITY IN LEAF PRODUCTION

3.1 Introduction

Sustainability in the leaf production sector aims at long-term farming. As such, it embraces all aspects of optimising yield, usability and profitability of the crop and ensuring that it has been produced ethically while meeting reliable standards of integrity. It also aims at conserving the environment and improving the quality of life for farmers, their workers and surrounding communities.

The information provided within this document is designed to complement and expand upon, with greater specificity, certain pillars contained in CORESTA Guide No 3: Good Agricultural Practice (GAP) Guidelines. The CORESTA Guide No. 3 sets forth the framework and key pillars of good agricultural practices, which a responsible organization/individual should take into account when establishing local good agricultural practices. The Sustainability in Leaf Production Guidelines document is another tool to assist in the establishment of agricultural practices, which further enhances sustainable tobacco production.

3.2 Seedling Production

A healthy transplant or seedling is the foundation for a successful field crop and better ensures a positive economic return to the farmer. Achieving favourable economics depends upon the grower's ability to enhance productivity by deploying sustainable crop production practices, including a carefully designed appropriate seedling production system. This is the first step towards achieving economic resilience and a successful crop season.

The seedling production phase involves an interplay of soil or soilless media, water, nutrients and the environment for successful production of healthy seedlings in a variety of systems from seedbeds to modified hydroponic systems. Interaction of these critical elements, along with proper management, results in the production of healthy seedlings and optimisation of the factors affecting the long-term sustainability of the farm. The objective of this section is to outline the importance of critical factors in seedling production and suggest indicators to preserve the natural ecosystem.

These guidelines highlight the importance of preserving water, environmental and soil (including soilless media) resources.

3.3 Seedling Production – Water Management (volume, availability and quality)

I. Context/ Background

Water resources have been under increasing pressure due to increasing water demand and limited water supply. Only 3 % of the world's water is fresh water and only 1 % is readily available for human, agricultural and industrial use. Around one-third of countries in the world are considered to be "water stressed " and this proportion is predicted to rise strongly due to increasing demand from a growing population, improving standards of living and a shifting water supply related to climate change.

Seedling production requires clean water, which should be used efficiently from a sustainable source. Farming activities should be organized so that the natural water bodies and drinking water supplies do not become contaminated or depleted.

There is an array of technologies to improve water use efficiency during seedling production, such as: micro-irrigation; intact root seedling production; hydroponics (e.g. float systems); etc.

Embedding the principles of these technologies within the current seedling production system is imperative to ensure sustainable water use.

II. Guidelines

Efficient utilization of water and protection of water quality are of paramount importance during the seedling production stage in order to produce robust & healthy seedlings with a minimal water usage footprint.

1. Production techniques must be selected based on the local conditions and infrastructure availability, and application techniques must be appropriate for the relative availability of water to ensure efficiency in water use.
2. Irrigation scheduling should be based on the water requirements of seedlings and adjusted according to ambient conditions. The use of soil moisture sensors should also be considered to improve irrigation efficiency and water management.
3. Micro-irrigation systems like micro-sprinklers can be used for overhead irrigation of seedbeds to reduce total water requirements, particularly during times of high evapotranspiration. Such systems are often cost effective in various configurations.
4. Excessive irrigation, in addition to being inefficient and unsustainable, can lead to the production of weak seedlings and increase the risk of root and leaf diseases, thus it should be avoided.
5. In soil-based systems of seedling production, base irrigation scheduling (i.e. frequency and amount of irrigation) on the water requirements at each stage of growth to avoid either under- or over-irrigation. In float systems, keep a minimum depth of water that is just enough for proper seedling production. This will reduce water and fertiliser usage.
6. Alternative seedling production techniques using soilless media and resetting the young seedlings into eco-friendly trays or beds typically reduces the water requirement, as compared to poorly managed traditional bare-root seedlings. Advanced techniques of seedling production like hydroponics, are extensively used in horticultural crops like vegetables and flowers. They contribute towards water and other resource conservation, and further embed climate resilience into the seedling production phase of a cropping cycle.
7. Adopt practices such as clipping, mulching, etc., to reduce evapotranspiration.
8. The use of shade for the protection of seedlings, where needed, can reduce the water requirements by lowering evapotranspiration (ET). Suitable shade materials include UV stabilized shade nets, palm leaves, agro-waste materials, etc.
9. Growers should seed greenhouses / seedbeds at appropriate times in order to avoid maintaining / managing seedlings for excessive lengths of time in order to minimize water use and pest pressure.

III. Suggested Indicators

a. The amount of water required for production of enough usable seedlings to plant one hectare of tobacco is an objective measure for determining the efficiency of the seedling production system.

IV. Additional Information

1. United States Geological Survey: Where is Earth’s Water?
2. UNESCO International Hydrological Programme: Water Security – Responses to Regional and Global Challenges (2014-2021)

3.4 Seedling Production – Environment

I. Context/ Background

Seedling production is a critical activity and involves the use of several inputs such as seeds, water, fertilisers, crop protection agents (CPAs), trays, soil or soilless media, mulch and protective covers. Some of these materials require careful handling and disposal, as appropriate before, during and after the production of seedlings. Some materials can potentially damage the environment, if improperly handled.

Several seedling production methods are used in different parts of the world, and range from conventional bare-root seedbeds to float system production, which uses a combination of the above listed materials. Float system production is practiced by large, intensive farmers and small-scale growers with relatively simple production systems. In contrast, bare-root systems are more typically used by small-scale growers.

Residual water from seedling production may contain nutrients and CPAs, therefore proper management is required to mitigate runoff and leaching from conventional seedbeds, and disposal of float water. Proper disposal of residual float water may include: evaporation, and where diseases are not a concern, land application as transplant water and/or as supplemental irrigation.

In many seedling production systems, equipment and growing containers are reused from season to season. Proper sanitation practices, particularly in reference to growing containers like float trays, should be utilized to minimize pest accumulation and damage to tobacco seedlings. Historically, Methyl Bromide was used to disinfect float trays but its use has been banned from production following the Montreal Protocol. Steam treatment has become a more appropriate and sustainable alternative.

II. Guidelines

1. In float systems, manage water levels to avoid having excessive residual float water, by gradual reduction of water levels and avoiding unnecessary water additions, especially as seedlings approach the transplanting stage. Properly managing water requirements minimizes the amount of water that will need to be properly disposed of or wasted.
2. Use appropriate fertiliser rates, avoiding excessive application of nutrients that will not be taken up by the seedlings and will either be disposed of with remaining float bed water or potentially leached in plant bed systems. Both systems have the opportunity for off-target movement in the environment.
3. Consider sustainability when selecting containers, such as float trays. Ideal containers will be usable for multiple growing seasons with appropriate sanitation and/or will have environmentally conscious options for reuse or disposal.
4. Use appropriate CPA rates and have a plan in place for disposal of water containing CPAs where necessary to mitigate off-target movement and environmental contamination.

Where possible, seedling production materials should be (1) reused or repurposed; (2) recycled; or (3) properly disposed of when no other appropriate option exists. In most situations, reuse has less environmental impact than recycling, while recycling has less environmental impact than disposal.

III. Suggested Indicators

a. Percentage of farmers using locally defined best practices for their seedling production system.

b. Percentage of farmers adopting acceptable water disposal/management methods.

c. Percentage of farmers adopting acceptable reuse / recycling / disposal methods of waste materials used in seedling production.

IV. Additional Information

1. Clemson University Extension: Tobacco Transplant Production in Greenhouses
2. North Carolina Department of Agriculture & Consumer Services: Chemigation and Fertigation: Anti-Pollution Devices for Irrigation Systems
3. NC State University: Organic Seedling Production
4. NC State University: Conventional Seedling Production
5. NC State University: Seedling Production Poster (quick reference poster)
6. NC State University: Producing Conventional Tobacco Transplants in Greenhouses – Water Quality
7. University of Georgia: Production of Bare Root Tobacco Transplants
8. University of Kentucky: Burley and Dark Tobacco Guide – Management of Tobacco Float Systems
9. Virginia Tech University: Greenhouse Transplant Production

3.5 Seedling Production – Soil and Soilless Media Systems

I. Context/Background

Soil pasteurization is an important practice that seeks to provide a disease- and weed-free environment for the growth of tobacco seedlings. Seedling production on traditional seedbeds is a common practice by farmers in many growing regions, with a wide array of pasteurization methods employed - from no pasteurization and manual weed control, to less environmentally friendly options such as gaseous chemical fumigation, to more environmentally friendly options like solarisation.

In the case of soilless systems, farmers use a combination of growing media derived from various products. Whatever the final media mix, having established physical and biochemical characteristics is beneficial for successful seedling production (eg. devoid of disease-causing pathogens, enough pore space to ensure appropriate water retention/drainage, etc.).

The media used for seedling production should be from a sustainable source. For example, sphagnum peat-based media has a proven track record in seedling production; however, the long-term sustainability of peat has been questioned. Therefore, locally sourced alternatives should be researched and developed such as pine bark, coconut coir, worm castings, etc. Other organic based materials may be available which are from recognized sustainable and renewable sources. The current trend in tobacco seedling production is to reduce the amount of peat in a media blend by the addition of sustainable organic materials, such as composted waste materials and coconut by-products.

Similarly, many of the tobacco growing regions have shifted to the use of soilless media derived from various sources (pine bark, coconut, farmyard manure, compost, etc.). The physical and biochemical properties of these materials are important in supporting the growth of the seedlings, as is the availability of a consistent media product for the farmers to use.

II. Guidelines

1. Using soilless media, devoid of weed seeds and disease-causing organisms, and derived from various plant sources can be used for seedling production.
2. Use of renewable media is preferred for seedling production.

3. Soil and float tray pasteurization with methyl bromide is not recommended due to its impact on the environment, rendering it not permitted for use (Montreal Protocol).
4. Burning of agro-wastes on the seedbeds, while often effective at soil pasteurization, has an impact upon the nutrient transformation process and is not considered to be the most environmentally appropriate practice.
5. An effective soil pasteurization process, which minimizes the environmental impact and enhances the soil characteristics, such as solarisation, is preferred. Similarly, Styrofoam and plastic float trays may be treated with steam.
6. Homemade media is one option to avoid peat use, but it poses production risk such as diseases, inconsistent performance, etc., thus requiring more stringent management and attention.

III. Suggested Indicators

a. The media used for seedling production must be consistent and within locally defined parameters. It is helpful to have locally prescribed and recommended physical characteristics, such as pore volume, bulk density, etc. and chemical characteristics such as electrical conductivity, cation exchange capacity, pH, C:N ratio, etc.

b. Percentage of farmers using locally acceptable renewable media that is acceptable for tobacco production.

IV. Additional Information

1. University of Kentucky: Burley and Dark Tobacco Guide – Management of Tobacco Float Systems
2. University of Tennessee: An Introduction to Small-Scale Soilless and Hydroponic Vegetable Production
3. Methods for Management of Soilborne Diseases in Crop Production (Panth, M., Hassler, S.C., Baysal-Gurel, F. 2020. Agriculture, 10(16). doi:10.3390/agriculture10010016)

3.6 Field Crop Management

Field crop management is the second phase in the crop growing cycle, and involves the efficient use of resources that ensure a successful crop. The activities of any crop production impact the soil and environmental health before, during and after the growing season. These changes should be defined, monitored, measured, and managed throughout the crop production phase to better sustain the long-term productivity of the current and future crop while protecting the environment and sustaining maximum economic returns to the growers.

The efficient use of natural resources is a paramount requirement for responsible agriculture.

The guideline highlights the importance of each phase of crop production, the associated impacts, and the indicators for measurement needed to support and strengthen sustainable management practices.

3.7 Field Crop Management – Crop Rotation

I. Context/ Background

It is widely agreed that crop rotation is a beneficial practice. However, there are many factors to consider in establishing an effective crop rotation system. These factors include, but are not limited to, cropping history/systems, soil borne diseases, fertility, agricultural practices, land pressure/availability, and seasonal weather patterns. There are multiple crop rotation systems that are effective and provide long-term sustainability. However, the effectiveness of unusual rotational practices, such as two successive years of tobacco followed by two or three years non-solanaceous crops, needs to be measured at an individual farm-level and cannot be deemed globally acceptable in all situations. Likewise, extremely long rotations, such as one year tobacco and six or seven years non-solanaceous crops, cannot always be deemed as a global best practice, unless rotational crops are produced in a sustainable manner and provide profitable income to growers.

A legume addition to crop rotation is often seen as advantageous, because legumes add nitrogen to the soil - although they may not always be the best choice, as certain diseases and slow released nitrogen could impact the following tobacco crop. The cost of establishment may render rotational crops unviable for the farmer. Where possible, the introduction of multiple species in a crop rotation has shown to be advantageous, since a broad range of species encourages the development of a diverse population of beneficial soil microorganisms. Therefore, careful consideration of multiple factors must be taken into account when selecting rotational crops.

In many countries, the availability of land limits the ability of farmers to practice effective crop rotation. In some places, cover crops or fallow fields have been implemented to assist in overcoming a lack of true crop rotation and effectively meet the local needs to break pest and disease cycles. However, this practice does not work in all situations; therefore, the local condition must be considered. A fallow period can be an effective practice in some areas, when used in conjunction with other crops, especially in areas where only one field crop can be produced per year (i.e. rain and dry season areas), and in areas where farmers lack resources to plant an alternative rotational crop. In these situations, a fallow period is generally longer than four months and the soil surface should be protected from erosion.

In some areas, soils are fumigated to overcome a lack of crop rotation; however, mono-crop cultivation can lead to a gradual decline in soil health. Therefore, fumigation solely to compensate for a lack of crop rotation is not considered a sustainable practice.

II. Guidelines

1. Legumes, cereals, other grass species, and other crops are grown widely as green manure and cover crops. Whichever rotational crop is selected, it should be fully vetted to ensure it is an appropriate fit in the entire farming system. The use of solanaceous crops should be avoided in tobacco rotations due to similarities in diseases and pests. If grown in any rotation scheme, enhanced management practices should be implemented to properly address potential pests and diseases.
2. Choice of crops should be based on the local availability and suitability for the growing conditions as well as economic viability for the farmer.
3. Almost any form of crop rotation (inter-cropping, fallow, cover crops, etc.) is better than a single crop (mono-crop) system, but may not be practical or effective for all situations. The generally accepted minimum crop rotation for tobacco is: one tobacco crop followed by two non-solanaceous crops, or a fallow period and one non-solanaceae crop.

III. Suggested Indicators

a. Physical characteristics (e.g. bulk density, aggregate stability, soil moisture, and soil temperature), chemical characteristics (e.g. soil organic matter status, pH, and soil nutrient cycle) and biological characteristics (e.g. soil flora and fauna, enzyme activities, and soil respiration) can be assessed periodically to determine the stability and/or enhancement of soil health related to farming activity.

b. Identify local crop rotation systems and quantify the percentage of farmers that are implementing acceptable rotational practices.

IV. Additional Information

1. [United States Department of Agriculture – Economic Research Service: Crop Rotations]
2. [Diversified Crop Rotation: An Approach for Sustainable Agriculture Production] (Shah, K.K., Modi, B., Pandey, H.P., Subedi, A., Aryal, G., Pandy, M., Shrestha, J. 2021. Advances in Agriculture, ID 8924087, https://doi.org/10.1155/2021/8924087)

3.8 Field – Soil Conservation

I. Context/ Background

Around the world tobacco is cultivated on a wide range of soil types and varying degrees of slope, tobacco is typically grown with relatively wide row spacing, often on ridges, and is normally cultivated multiple times, therefore a risk of soil loss by erosion exists. It is important to adopt all feasible soil conservation measures to achieve sustainable production and minimize soil erosion.

Sustainable soil management and conservation practices, which reduce erosion and support healthy plant growth, assist in keeping the soil in good health. Furthermore, soils become less productive if eroded, compacted from improper use of machinery and farm traffic, or damaged by inappropriate fertilization or irrigation practices, each of which also limits root growth. Eroded soil creates problems in water bodies and is a major cause of eutrophication and siltation. Soil compaction may be confused with poor soil fertility, which may lead to excessive fertilizer application with limited or even negative crop response.

Productive soils are fundamental to sustainable agriculture. Poor or non-existent erosion control practices have a negative impact upon the soil health status. It takes approximately 500-1000 years to form 2.5 cm of soil, and an annual erosion rate of 10,000 kg/ha, would result in approximately 2.5 cm of soil being lost in 3.7 years.

Land pressure/tenure, economic pressure and environmental factors can limit the use of cover crops, long rotations, and other practices that conserve the soil and improve soil structure, fertility, and productivity. However, other conservation practices can be implemented (contour ploughing & planting, leaving field residues, strip cropping, minimum-tillage, no-tillage, etc.) which have minimum financial impact and require limited land area. It is important to understand the local dynamics that may impede the adoption of certain beneficial conservation practices and identify and implement conservation practices which are achievable under the local conditions. Without productive and healthy soils, farmers will face ever-increasing production challenges and will fail to be sustainable in the long-term.

II. Guidelines

1. Identify the relevant components of a site-specific soil management plan and established procedures and practices that protect the soil from erosion.

2. Identify crops that are appropriate for specific soil types and in appropriate rotations and/or intercropping systems.

3. Conduct risk assessments of soil erosion/loss potential and soil compaction along with the identification of corrective/preventative practices.

4. Conduct risk assessments of soil chemical degradation and identify corrective/preventative practices.

5. Monitor soil health through measurement of identified soil health indices, which may include pH, soil organic matter, nutrient content, nutrient levels, bulk density, aggregate stability, soil respiration, microbial activities, disease incidence and build-up, as well as soil contaminants and salinization.

III. Suggested Indicators

a. Physical characteristics (e.g. bulk density, aggregate stability, and soil moisture), chemical characteristics (e.g. soil organic matter status, pH, and nutrient levels) and biological characteristics (e.g. soil flora and fauna, enzyme activities, and soil respiration) should be assessed frequently to determine the stability and/or status of soil health related to farming activity. Soil physical and chemical characteristics are commonly measured on an annual basis, while biological characteristics may be measured seasonally (e.g. at planting, during the growing season, and at harvest).

b. Programs should be defined and implemented for improving physical, biological, and chemical composition. In addition, the percentage of farmers following the guidelines and recommendations should be reported.

c. Percentage of farmers that adopt site-specific soil conservation practices.

IV. Additional Information

1. American Society of Agronomy (ASA): The Biology of Soil Compaction
2. Food and Agriculture Organization of the United Nations: Voluntary Guidelines for Sustainable Soil Management
3. NC State University: Managing Equipment Traffic to Limit Soil Compaction
4. NC State University: Nitrogen Management and Water Quality
5. NC State University: Soils and Water Quality

3.9 Field – Nutrient Management

I. Context/ Background

Fertilizer materials are important inputs for the economic sustainability of tobacco farming. Efficient fertilizer use impacts the long-term sustainability and viability of the soil and water resources.

Macronutrients and micronutrients should be provided in appropriate amounts to achieve economically viable yield and quality in an environmentally sustainable manner. Routine soil analyses, at least once every two to three years, identifies the pH and nutrient composition of the soil and assists with fertilizer recommendations. Such tests will assist in identifying nutrient deficiency and help develop a balanced nutrient application program that is based on the current nutrient levels and crop needs.

Indiscriminate use and over-application of nutrients are considered unsustainable practices since both are environmentally irresponsible as well as economically wasteful and potentially harmful to the crop. Excessive nutrients can find their way into the atmosphere and/or ground and surface water sources. This may result in eutrophication of water bodies and contribute to climate change. Applied fertilizer materials, both organic and/or inorganic forms, should be from known sources and with a known nutrient content. Avoid fertilizer materials that supply unnecessary or excessive nutrients that can have a negative impact upon leaf quality, such as chloride (Cl^-) and heavy metals (such as cadmium, nickel, copper, chromium, and lead).

Imbalanced nutrient application is counterproductive, impacting productivity and increasing the cost of production, thus eroding farmer profitability.

Nutrient management practices are often linked to economic factors. For example, over fertilizing for (perceived) yield increases and profit or under-fertilizing due to a lack of funds for fertilizer materials.

II. Guidelines

Nutrient Management System:

1. A basic knowledge of soil health is the starting point when creating a sustainable fertilizer recommendation. Factors such as soil nutrient level, soil type, soil organic matter content, and pH are also important and should be considered as well.
2. The nutritional requirements of tobacco to reach the target yield and quality must be known and translated into local specific operational recommendations.
3. Fertilizer recommendations should take into account actual nutrient availability from the soil, the soil's mineral composition, previous crop residues, cover crops, green manure crops, etc.
4. Nutrient leaching adjustments, particularly nitrogen, should be based upon crop stage, rainfall intensity (taking into account runoff and infiltration/percolation), and depth to subsoil (B soil horizon or clay layer).
5. Fertilization selection criteria should consider the following: supply availability, nutrient content, cost, ease of application, rate of nutrient release, and the potential for nutrient losses and off-target movement. Specific to tobacco fertilizer materials, the chloride and heavy metal levels should be known and minimized to ensure a commercially acceptable product.

Nutrient Application:

1. Avoid fertilizer application methods and dosages, which could contaminate surface and ground water. Suitable application technology, when it is available and affordable, and appropriate rates established by local fertilizer rate trials are the starting point to protecting this limited resource.
2. Considerations to avoid nutrient loss can include: fertilizer placement and time of application, choice of fertilizer material, fertilizer amount, soil condition, application technique/method, expected rainfall (and/or irrigation), and, in some cases, tillage practices.

III. Suggested Indicators

a. Measure "nitrogen balance" as an indicator for the amount of nitrogen released into the environment.

b. Soil health indicators, mentioned in the previous sections, are helpful indicators.

c. Match nutrient application based upon the crop's needs to achieve the desired style, yield and quality. Realistic yield goals that are specific to a growing environment and which are based upon dose-response studies should be referenced to ensure that excessive fertilizer rates are avoided.

d. Percentage of farmers covered under a soil analysis programme and application of nutrients at the recommended rate.

IV. Additional Information

1. North Carolina Department of Agriculture & Consumer Services: Burley and Flue-Cured Tobacco Reference Sufficiency Ranges
2. NC State University: Soil Acidity and Liming for Agricultural Soils
3. NC State University: Managing Nutrients for Tobacco Production
4. University of Kentucky: Tobacco Fertilization
5. Virginia Tech University: Tobacco Fertilization

3.10 Field – Water Management

I. Context/ Background

Water resources have been under increasing pressure due to increasing water demand and limited water supply. Only 3 % of the world's water is fresh and only 1 % is readily available for human, agricultural and industrial use. Around one-third of all countries are considered to be "water stressed", which is predicted to rise due to increasing demand from a growing population, improving standards of living and a shifting water supply related to climate change.

Productivity levels of several crops increase through the use of good quality irrigation water. Water availability helps improve input efficiency, and the associated benefits of productivity and crop quality are enhanced.

Water is arguably the most important factor for all crop production. In tobacco production, water alone has a profound impact upon quality and yield, as well as in conjunction with other inputs such as fertilizers and CPAs. Tobacco can be negatively affected both by too much and too little water. However, the tobacco plant uses water efficiently and requires less water than many other commercial crops such as rice, maize, sugar cane, etc. Correct timing (crop stage) of applied water can greatly assist in reducing over-irrigation. Drought can have a negative impact on tobacco as well. A lack of irrigation equipment, and/or available water is a concern to farmers in many countries. Likewise, periods of excessive rainfall, and the lack of resources to effectively manage this condition is also likely to have a negative impact. The availability and access to water with acceptable quality and its efficient use through irrigation equipment and technology can greatly assist in stabilizing productivity and tobacco leaf quality.

II. Guidelines

1. Prioritize access to good quality irrigation water. This is achieved through several different ways in different parts of the world including:
    a. rainwater harvesting and storage through contour bunding (tie ridges), dams, weirs, etc.
    b. watershed development involving farmers, businesses, village representatives, water boards, environmental agencies, etc. for recharging water sources (ground and surface).
2. Use irrigation water efficiently through the adoption of appropriate and cost-effective practices and equipment.
3. Timing and irrigation amount must be tailored to crop requirements to avoid nutrient leaching and to meet the target productivity levels for a particular region.
4. Application techniques should be appropriate and suit the availability of water, soil type, slope, etc.
5. Water should not be over-applied and mechanisms to regulate water supply should be in place.
6. Irrigation should be used based on the ETc (evapotranspiration and crop coefficient), which is a numerical factor that relates the ET of the individual crop ETc to the reference ET.
7. Irrigation water quality should be monitored to avoid potential deterioration of crop quality, particularly in areas near water bodies with excessive chloride.
8. Equipment used for irrigation should be maintained and calibrated periodically.
9. The effects of drought and excess rainfall situations should be identified and communicated to the growers.

III. Suggested Indicators

a. Establish water use efficiencies under local production systems. Water use efficiency varies with soil texture, soil water holding capacity, water infiltration, soil organic matter level, growth pattern of tobacco, evapotranspiration and rainfall characteristics. The percentage of farmers who implement practices to minimize irrigation requirements and maximize water use efficiency should be reported.

b. Quantify the water required/applied to produce tobacco (mm/ha; litres/ton; inches/acre, gallons/acre, litres/ha, etc.) and identify practices, where feasible and applicable, to reduce the amount of water applied. In addition, annual water use reduction should be quantified from one growing season to the next.

c. Monitoring the water table depletion/drawdown in tobacco growing areas and measure extraction rates compared against replenishment rates.

IV. Additional Information

1. Food and Agriculture Organization of the United Nations (FAO-UN): The State of the World's Land and Water Resources for Food and Agriculture
2. NC State University: Soil, Water, and Crop Characteristics Important to Irrigation Scheduling
3. United States Department of Agriculture: Natural Resources Conservation Service – North Carolina Irrigation Guide
4. United States Geological Survey: Irrigation Water Use
5. University of Florida – Fertigation for Vegetables: A Practical Guide for Small Fields
6. University of Georgia – Irrigating Tobacco
7. Water Risk Atlas (interactive portal)

3.11 Field – Crop Protection Agents (CPAs) and Integrated Pest Management (IPM)

I. Context/ Background

The objective of IPM is to adopt cultural, biological, mechanical, physical and other strategies in addition to CPAs to minimize crop loss from disease and pest attack. IPM allows for the use of locally registered and recommended CPAs for tobacco. However, IPM prioritises other control mechanisms before the selection and use of a CPA. Potential benefits of an IPM strategy include reduced worker exposure to CPAs, reduced CPA resistance pressure and lessened environmental impact. Less reliance on CPA applications will result in cured tobacco with lower CPA residues. This will be manifest in the number of compounds present and their residue levels present.

In a global context there are a limited number of CPAs registered for use on tobacco. Within the tobacco industry there are stakeholders with varying views on the acceptability of some of these registered products. Even though the first requirement is that all CPAs used in tobacco must be compliant with local legislation and recommended for tobacco use within the country, the choice of safer options with less impact on people and the environment as recommended by Global Guidelines has become an important factor in determining the acceptability of tobacco, in addition to CPA residues.

Some countries lack the newer more modern IPM products and/or strategies; while other countries simply fail to use them. IPM programmes have been proven to be effective in reducing CPA use and associated residues, while producing an acceptable tobacco crop. The development and utilization of IPM is fundamental to the long-term sustainability of tobacco production.

II. Guidelines

1. Identify effective pest (weed, disease, insect, nematode, etc.) control mechanisms, practices, and devices/products alternative to CPAs. Develop a tentative management protocol for common pests using available aspects of IPM and implement where pest thresholds are met.
2. Identify pests and beneficial organisms in the field, understand their life cycle (morphology, biology, and ecology) and establish economic threshold levels that are specific to production origins and tobacco types.
3. Implement farmer training on the principles of IPM for key pests. This includes threshold values, proper scouting techniques and methods, control strategies, and other important details.
4. Thoroughly scout fields for pests at multiple crop stages.
5. Use alternative methods and/or cultural control practices before applying CPAs.
6. Use only approved and registered CPAs in accordance with their label, when the economic threshold levels are reached, and where alternative methods are not appropriate. The selection of pest-specific CPAs (narrow-spectrum or selective), as compared to broad-spectrum CPAs, is more environmentally responsible as it reduces the impact to non-target organisms.
7. Eliminate the use of Highly Hazardous Pesticides (HHPs) in the supply chain, with a focus on WHO group 1a (extremely hazardous) and 1b (highly hazardous) toxicity classifications.
8. Follow safety guidelines when using CPAs (handling, application, storage, disposal, etc.). This information can be found on each CPA label.
9. Pest and disease forecasting systems and weather stations where available can be beneficial IPM tools. Monitoring information should be shared across production regions.

III. Suggested Indicators

a. CPA residues detected in the cured leaf can be an indicator of which CPAs were used.

b. A declining trend in the number of CPA residues detected and/or declining residue levels can be an indicator of the effectiveness of IPM and CPA reduction practices.

c. Number of effective bio-pesticides recommended versus conventional.

d. Number of trainings on pest and disease identification, scouting techniques, economic thresholds, CPA usage, etc.

IV. Additional Information

1. CORESTA Guide No. 1 – Agrochemical Guidance Residue Levels (GRLs)
2. CORESTA Guide No. 3 – Good Agricultural Practices (GAP) Guidelines
3. CORESTA Guide No. 19 – Responsible Use of Crop Protection Agents (CPAs) in Tobacco Leaf Production
4. CORESTA Guide No. 21 – Cigar Tobacco: Best Practices, Crop Protection, and CPA Guidance Residue Levels
5. CORESTA Guide No. 27 – Identification and Elimination of Highly Hazardous Pesticides (HHPs) in Leaf Tobacco Production
6. CORESTA Integrated Pest Management Sub-Group

7. [United States Environmental Protection Agency: Introduction to Integrated Pest Management]
8. [United States Environmental Protection Agency: Integrated Pest Management (IPM) Principles]
9. [World Health Organization: The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification 2019]

3.12 Field – Variety / Cultivar Selection and Host Resistance

I. Context/Background

Variety or cultivar selection is one of the single most impactful decisions a farmer or agronomist will make. Due to the economic impact of diseases in tobacco, it is important to consider disease resistance first when selecting varieties. The use of varieties with higher levels of resistance, in combination with appropriate CPAs (Crop Protection Agents) is often an effective integrated pest management (IPM) approach that reduces the impact of pests and disease in a long-term, sustainable manner. By reducing the use of CPAs and their residue levels, this method also reduces the risk of developing disease populations resistant to available CPAs.

Secondary characteristics to consider in variety selection are yield potential, economic value, visual quality, cured leaf colour, maturity level (early, medium, and late), holding-ability and buyer preference for cured leaf style. Quality-related secondary characteristics are predominantly influenced by the varieties' leaf chemistry traits, including levels of total sugar (TS), reducing sugar (RS), total nitrogen (TN), nicotine (NIC), and total potassium (TP). Additional characteristics that may be considered may include stalk height, leaf number per plant, and leaf architecture/orientation.

Most variety characteristics can be influenced by disease pressure, cultural practices, and environmental factors, which may lead to differences in outcome within varieties. Cultural practices, such as sanitation, tillage, and crop rotation can help minimize disease pressure, maximizing the efficacy, yield, and quality of resistant varieties. When selecting varieties, one should refer to unbiased, replicated research-based information reflecting the practices and environment in one's location, when possible.

II. Guidelines

1. Resistance information pertaining to diseases such as black shank, bacterial (Granville) wilt, tobacco mosaic virus, brown spot, root-knot nematodes, and tobacco cyst nematodes are typically available across production origins.
2. Identify plant varieties with host resistance tailored to pests and diseases in specific fields.
3. Good to excellent host resistance should be paired with recommended CPAs and other cultural practices to manage disease impact and resistance.
4. The above factors should be considered in coordination with other variety characteristics that are desired by purchasers.

III. Suggested Indicators

a. Locally identified varieties and percentage of farmers utilizing resistant varieties.

b. Reduced disease incidence and increased yield in locations with a history of moderate to high disease pressure can indicate the effectiveness of variety resistance.

IV. Additional Information

1. CORESTA Field Guide to Integrated Pest Management
2. NC State University - Tobacco Production Guide: Managing Diseases (pp. 111-134)
3. University of Kentucky – Tobacco Production Guide: Selecting Burley and Dark Tobacco Varieties (pp. 3-10)
4. Virginia Tech University – Tobacco Production Guide: Disease Control (pp.47-64)

3.13 Prevention of NTRM and Taints

I. Context / Background

Incorrect tobacco handling, curing and storage practices may increase the risk of Non-Tobacco Related Material (NTRM), taints or chemical residues in tobacco.

NTRM is anything found in tobacco that is not tobacco lamina or stems. NTRM can be categorised as synthetic, non-synthetic and organic, including parts of the tobacco plant such as stalks, suckers, flowers, and roots.

NTRM is an important issue because its presence will jeopardize the integrity of tobacco and, as a major industry concern, it must be addressed effectively.

Examples of NTRM include, but are not limited to: plastic, rubber, metal, glass, netting, foam material, insects, cocoons, feathers, leather, fur, cigarette butts, hessian and cotton string, cloth, lint, paper, grass, weeds, straw, stalks, food, fruit and sand.

Excessive chemical residues in cured leaf can occur due to improper pesticide application during the growing season, off-target drift from surrounding crops, or carryover from the previous crop.

The key objectives of these guidelines are to enable tobacco companies and growers to develop and deploy local best practices to minimize the risks of NTRM, taints and chemical residues in tobacco during handling of fresh leaves, curing and cured tobacco storage.

II. Guidelines

Most NTRM originates at the farm level. Preventing the introduction of NTRM in tobacco at this stage is the most effective way of addressing the problem; therefore, this is where most efforts must be focused.

The tobacco leaf purchaser should implement a system to provide feedback to tobacco growers on the presence of NTRM.

Cured leaf residues also originate at the farm level. They can be largely avoided by applying CPAs according to the label in tobacco and surrounding crops, focussing on application requirements including rate, pre-harvest interval, and weather conditions. Additionally, farmers should not plant tobacco near or after other crops with potential for CPA drift or carryover, respectively, which can result in problematic residues in tobacco and/or severe crop damage.

III. Suggested Indicators

a. A standardised monitoring and reporting system for NTRM throughout the tobacco supply chain.

b. Training and awareness programme that targets all key stakeholders within the supply chain.

IV. Best Practice

General

1. Introduce a clause, where applicable, in the farmer/supplier contract stating that tobacco containing NTRM will not be accepted and/or may require re-handling at the farmer's/supplier's cost.
2. Develop and distribute training material that is concise, ideally pictorial and easy to understand.
3. Provide training to farmers and workers who are involved in crop production.
4. Assessment of NTRM risk, farm by farm, prior to tobacco handling, curing, sorting and baling by on-farm inspections.
5. Provide feedback to farmers on NTRM contamination identified in their bales.
6. Farmers should apply CPAs in accordance with their respective labels.

Sanitation

Some of the principal aspects to be considered relating to sanitation are:

1. All curing barns and tobacco storage areas inspected, and routinely cleaned before harvest begins and must be kept free of storage pests at all times.
2. All areas where tobacco is handled are kept clean throughout the whole crop production cycle.
3. No food or drink items are allowed in areas where tobacco is handled (sweet wrappers, coffee cups, drink containers, etc.).
4. Tobacco storage facility is isolated, sufficient, appropriate, and free of NTRM.
5. Potential sources of taints should be considered and removed from tobacco production systems. Animals and livestock should be kept away from tobacco and tobacco handling facilities (curing barns and/or curing areas, grading sheds, storage areas).
6. All vehicles, equipment, containers and materials used for tobacco transport are clean and, where appropriate, provide protection against potential contamination.
7. Collection/disposal programs should be managed in a way that avoids NTRM contamination.

3.14 Glossary of Technical Terms

Bare root seedling: Usually refers to tobacco seedlings produced in conventional seedbeds. The term "bare root" indicates the lack, or limited number, of fine root hairs present when the seedling is removed (drawn or pulled) from the soil prior to transplanting. Conventional seedbeds are often raised soil beds, or prepared soil, where raw tobacco seeds are sown directly onto the soil surface. The soil surface of the bed is typically covered with a thin layer of organic mulch (e.g. straw, compost, etc.) or a row-cover (e.g. plastic sheeting, spun polyethylene sheeting, etc.) to facilitate seed germination and reduce seed movement immediately after sowing.

Chemigation: The application of crop protection agents (CPA) through an irrigation system. This can be done during seedling production and/or in the field, but only if the proper equipment is installed and the CPA label allows this application method.

Eutrophication: The process by which a body of water becomes enriched by a high concentration of dissolved nutrients (e.g. nitrates & phosphates) that stimulate the excessive growth of aquatic plant life (e.g. algae). As the excessive aquatic plant life die and decompose, high levels of organic matter and the decomposing organisms typically result in the depletion of available water-dissolved oxygen, causing the death of other aquatic organisms, such as fish.

Fertigation: The application of fertilizer material/nutrients through an irrigation system. This can be done during seedling production and/or in the field, but only if the proper equipment is installed.

Intact root seedling: Most commonly indicates tobacco seedlings grown in containers (e.g. polystyrene trays, plastic containers, peat pots, etc.) where the majority of the seedling's fine root hairs are present for field transplanting. Intact root seedlings can also be produced without containers/trays such as in media beds, and in rare cases in conventional soil seedbeds if additional efforts to significantly loosen the soil (e.g. under-cutting, spade digging, etc.) prior to seedling removal for field transplanting.

Semi-hydroponics: refers to a plant production system where the growing of plants occurs in a water-based nutrient solution normally without the use of soil. Typically, the plant's roots are submerged in a water/nutrient solution and the plants grow with or without an inert medium (sand, gravel, rock wool, organic media, etc.) to provide mechanical support. The tobacco seedling float system, a typical example of hydroponic seedling production utilized in tobacco cultivation, generally uses polystyrene (or floating plastic/Styrofoam) trays which float on pools of water with added nutrients and/or CPAs. The trays are most often filled with an organic growing media (e.g. peat moss), and the media wicks the nutrient solution upwards saturating the media and the raw tobacco seed to induce germination. As the seed germinates and the seedling develops, the roots grow downward through holes in the trays and into the water/nutrient solution.

Soilless seedling: Refers to seedlings grown in production systems that do not utilize soil in the production of tobacco seedlings. Non-soil growing media may include peat and sphagnum peat moss; compost; rock wool; coconut peat; worm castings, etc.

Solarisation: Soil solarisation is a nonchemical technique in which transparent polyethylene tarps/sheets are laid over moist soil for a 6-to-12-week period to heat non-cropped soils to temperatures lethal to nematodes and other soil-borne pathogens. To be effective, soils must be wetted and maintained at high soil moisture content to increase the susceptibility (thermal sensitivity) of soil borne pests and thermal conductivity of soil. Soils with poor water holding capacity and rapid drainage can significantly inhibit heat transfer to deeper soil horizons. The most successful use of soil solarisation appears to occur in heavier (loamy to clay soils) rather than sandy soils. Loss of pest control is directly correlated with soil depth, with a limiting soil depth of 15-20 cm for lethal temperature to be achieved depending upon the intensity and duration of sunlight and ambient temperature. Many different pests can be suppressed and/or controlled by soil solarisation, particularly within arid environments with intense sunshine and limited cloud cover and rainfall. Plant parasitic nematodes have generally proved to be more difficult to control with soil solarisation, as have some weed pests.

4. GUIDELINES ON CURING BARN EFFICIENCY

4.1 Context / Background

Some leaf tobacco requires supplemental heat to cure and dry the green leaf to realize the desired properties and characteristics. Globally, there is a wide range of curing barns in use today, from traditional barns constructed of wood and mud to extremely efficient, commercially produced bulk barns. There is also a wide range of furnaces, heat distribution and control system designs that are incorporated into the barns. This guidance document is not intended to describe all possible configurations of barn types and heating system designs, as doing so would require a manual of its own. Rather, it should serve to supplement the current CORESTA GAP Guidelines and will identify options that should be considered for improving barn, heat source, heat exchanger and airflow efficiency. These considerations should lead to minimized fuel consumption, associated waste and air emissions, and reduced net cost to the grower - all without compromising cured leaf quality.

The key objectives of the guidelines on curing barn efficiency are to facilitate tobacco companies in:

- Holistically assessing the combination of efficiency improvement options available that provide the highest level of sustainability from the point of view of the farmer, environment and community.
- Developing and implementing locally appropriate strategies for continually improving overall curing efficiencies.

4.2 Guidelines

Efficiency improvements should be:

1. Economically viable for the farmer
2. Cumulative and long-term
3. From sustainable and renewable sources, where possible
4. Low maintenance
5. Measured against an efficiency target

Continuous technical support and encouragement towards the adoption of long-term, cumulative improvements for curing barns, is necessary for maximizing sustainable net income for farmers.

Appropriate local best practices should be developed in each region that encourage adoption by growers to significantly reduce pressure on wood and other fuel supplies, while incrementally reducing the labour requirements of farmers and increasing their net income. This document is separated into efficiency improvement guidance for Traditional Curing Barns and Commercial Bulk Barns.

Many curing barns use wood as a heating fuel. All wood fuel should originate from a sustainably managed source or should be obtained as a by-product , such as tree trimmings, sawdust, lumber offcuts, etc. that would otherwise become a waste material. Protected forests should not be used for wood fuel or cleared for new plantations. Companies should ensure that adequate education, technical support and encouragement through contractual obligations are provided to growers, as needed.

Cooperation with governments, non-governmental organizations (NGOs) and third-party wood suppliers should also be sought to ensure that long-term strategies and plans are developed and implemented at a local and national level, to provide future sources of sustainable wood products. In addition, processes to verify wood fuel sources should be developed.

4.3 Traditional Curing Barns

Fuel efficiency modifications to traditional curing barns and associated benefits include:

- Designing curing barn capacity to match expected crop size, and thereby fully and most efficiently utilising the heat generated.
- Correct leaf loading and density to optimise fuel efficiency, while improving quality and yield.
- Using hygrometers and/or wet/dry bulb thermometers to either automatically or manually control relative humidity during flue-curing, thus minimizing fuel wastage and optimising leaf quality and yield.
- Improving insulation in the curing barn to minimize heat loss through the structure.
- Where appropriate, conversion of open furnaces to venturi type furnaces with a sealed door to increase the heat that is available for curing from the fuel combustion process.
- Designing and installing a furnace flue (duct) system that will distribute heat uniformly across the bottom of the barn to provide even temperatures within the curing chamber.
- Installing intake dampers and vents that are properly sized, located and easy to control.
- Optimising chimney height to maintain efficient furnace airflow rates.
- Converting to continuous forced-air fans that are electrically driven.

4.4 Commercial Bulk Barns

Fuel efficiency modifications to commercial bulk curing barns that should be considered:

- Walls, floors, ceilings and doors need to be insulated to reduce significant heat loss. Consider various insulation materials, according to availability. Use material with a high R-value (heat insulating property) and that does not absorb moisture, such as fibreglass batt, polystyrene board, or polyurethane. Special care must be taken to ensure adequate maintenance to prevent potential contamination of tobacco with NTRM from insulation materials.
- Seal the exterior foundations of bulk curing barns with an asphalt or equivalent type sealant. This material will expand and contract as the barn heats up and cools down during the curing season. A small crack between the foundation and pad area can cost more money in terms of energy loss than the minimal cost of sealing.
- The use of automated fuel feeding for biofuel/biomass systems and curing control devices to improve fuel efficiency, optimise cured leaf quality and decrease net cost to the farmer. Where conventional liquid or vapour fuels are used, burners should be properly tuned each season.
- Using hygrometers and/or wet/dry bulb thermometers to either automatically or manually control relative humidity in flue-curing, to minimize fuel wastage and optimise leaf quality and yield.

4.5 Suggested Indicators

a. Average fuel efficiency rating for each type of fuel that is used, which should be measured in Heat Units/kg green tobacco (BTU/lb, kcal/kg, kJ/kg, kg wood consumed/kg cured leaf, etc.).
b. Percentage of curing fuel from renewable sources.

Average fuel efficiency rating for each type of fuel that is used, which should be measured in Heat Units/kg green tobacco (BTU/lb, kcal/kg, kJ/kg, kg wood consumed/kg cured leaf, etc.).

5. GUIDELINES ON BARN CONSTRUCTION MATERIALS

5.1 Context/ Background

The majority of leaf tobacco produced today is cured in some type of structure after harvesting, either for air-curing or through adding heat, as in the case of Flue-Cured Virginia (FCV). Dark Fire-Cured (DFC) tobacco barns utilize both smoke and heat for curing. These structures range from simple, manually-constructed temporary sheds built from locally collected natural materials, to factory-built metal barns with sophisticated furnaces, controls, forced-air ventilation systems, insulation and thermal seals that are designed for mechanically harvested leaf loaded in bulk racks or boxes. This guidance document is not intended to describe all possible configurations of barn materials and design – doing so would require a manual of its own. Instead, this work serves as a list of many of the materials that have been used in practice or in trials and identifies the benefits and challenges of how each relates to sustainability of the environment, the community and the farmer.

The key objectives of the draft guidelines on barn construction materials are to help the industry to:

- Holistically assess the combination of locally available construction materials that provide the highest level of sustainability, in regard to the grower, environment and community.
- Develop and implement locally appropriate and cost-effective methodologies for addressing the selection of sustainable materials for construction of curing barns.
- Develop barn designs, construction methods and procedures for constructing structurally sound buildings with a focus on safety, both during and post construction.

5.2 Guidelines

Barn construction materials should preferably be:

1. Locally available
2. Economically viable for the farmer
3. From sustainable and renewable resources
4. Long lasting
5. Low maintenance
6. Free from material that could result in NTRM, taint or contamination risk
7. Of the highest reasonably possible "R" value (heat insulating value) for heated curing barns (lower R values are likely to suffice in warmer climates)
8. Resistant to moisture

Most types of curing barns and on-farm storage buildings use wood products to some extent as a construction material. All wood material should originate from a sustainably managed source. Indigenous forests should not be used for wood products or cleared to plant new forests. The industry should ensure that adequate education, technical support and encouragement through contractual obligations are provided to growers, as needed.

Cooperation with governments, NGOs and third-party wood suppliers should also be sought to ensure that long-term strategies and plans are developed and implemented at a local and national level to provide future sources of sustainable wood products. In addition, processes to verify sources of wood products should be developed.

Where appropriate, the industry should provide growers with curing and storage barn designs, construction and operating methods to produce structurally sound buildings that are based on procedures that focus on safety.

The guidelines for barn construction materials are broadly categorized into three sections that are based on distinctive barn designs and requirements. These include: (a) Air-curing barns; (b) Convection air flow heat cured traditional barns and (c) Forced air flow heat cured bulk barns, such as bulk curers.

5.3 Air-Curing Barns and Drying Racks

Continuous support and encouragement to growers towards the adoption and construction of long-lasting air-cured barns and dry racks (traditional open-air sun-drying process), using sustainable and renewable materials is constantly needed. The industry should develop locally appropriate best practices in each region and enforce adoption by growers to significantly reduce pressure on wood supplies for construction materials, while gradually reducing the labour requirements of farmers and increasing their net income.

1. Where applicable, smallholder growers should consider transitioning from traditional air-curing barns to "live" barns. This type of structure uses living trees as the structural poles to support the roof and tiers. This is a long-term strategy which requires planting appropriately selected trees at correct spacing and allowing growth for several years before use. This method leaves the "poles" (tree trunks) resistant to rot, termites, and fire. In addition, the net cost to the farmer is lower, reduces labour requirements for transporting poles, and has a much longer useful life than traditional barns, thereby enhancing biodiversity, carbon capturing from the atmosphere and provision of homes for fauna.
2. Where cement is locally available and economically viable, air-curing barns can be constructed using locally produced sun-dried bricks for supporting columns on top of a cement footing base. Likewise, concrete-cast poles may be an economically advantageous option in some locations.
3. Where cement is prohibitively expensive and transitioning to live barns slow, wood structural materials should come from a renewable and sustainable source.
4. Where available, bamboo should be used for structural support and for tobacco sticks that will be used to hold leaves during curing.
5. Using portable hygrometers to monitor and control relative humidity.

5.4 Heat-Cured Traditional Barns

Continuous support and encouragement to growers towards adoption of long-term construction of heat-cured barns using sustainable and renewable materials is necessary. The industry should develop locally appropriate and affordable best practices in each region and enforce adoption by growers to significantly improve fuel efficiency and reduce greenhouse gas (GHG) emissions, while gradually reducing the labour requirements of farmers and increasing their net income.

Wood material used for building materials should be from a sustainable source. Brick or concrete is often selected as a building material for its reasonable insulation qualities and durability.

Walls, floors, ceilings and doors should be insulated in traditional flue-cured barns. Walls and ceilings should also be insulated in fire-cured barns; however, floor insulation may not always be feasible or practical. Consider several kinds of insulation materials, according to availability.

Use material with a high RSI-value (>0.88 K·m^2/W, if possible) and that does not absorb moisture, such as fibreglass batt, polystyrene board, or polyurethane. Additional materials, such as Tyvek® House Wrap, may be used to help achieve the desired R-value of existing insulation and to lengthen the life of other barn construction materials. Materials such as Tyvek® House Wrap have an extremely low RSI-value (<0.04 K·m^2/W) but inhibit water and some air infiltration into curing barns. All insulation should be correctly secured and covered to prevent against the introduction of NTRM into the tobacco leaf. Thatching, when done correctly, may be used to provide additional insulation and protection for roof structures.

Conserve fuel by employing the most energy efficient curing structures and heating equipment, balancing barn (kiln) capacity with its capability to cure efficiently, and curing using the technique that optimises output while maintaining the desired cured leaf quality.

5.5 Heat-Cured Bulk Barns

Growers should be continuously supported and encouraged to adopt long-term construction of heated forced-air ventilation bulk barns using sustainable and renewable materials. Industry should develop locally appropriate and affordable best practices in each region and enforce adoption by growers to significantly improve fuel efficiency and reduce GHG emissions, while gradually reducing the labour requirements of farmers and increasing their net income.

1. Walls, floors, ceilings and doors need to be insulated to reduce significant heat loss. Consider various insulation materials, according to availability and affordability. Use material with a high R-value (heat insulating property) and that does not absorb moisture, such as fibreglass batt, polystyrene board, or polyurethane.

Table 1. Insulating Value

Insulation Materials	R-Value per inch	RSI
	F°·ft^2·hr/BTU	K·m^2/W
Tyvek® House Wrap[1]	<0.2	<0.04
Concrete Block 4"	0.2	0.04
Fibreboard	2.64	0.46
Fibreglass (glass wool)	4	0.70
Extruded Polystyrene	5	0.88
Polyurethane (foamed-in-place)	6.25	1.10

[1]Tyvek® House Wrap is not an insulating material, but does prevent the introduction of moisture and some air into the curing barn.

2. Designs and materials that minimise the labour needed to fill and unload the barn should be used.
3. Barns, where relevant, that incorporate the most efficient heating system designs available.
4. Seal the exterior foundations of bulk curing barns with an asphalt sealant. This material will expand and contract as the barn heats up and cools down during the curing season. A small crack between the foundations and pad area can cost more money in terms of energy loss than the minimal cost of sealing.

5. The use of automated fuel feeding and curing control devices as they can help to optimise cured leaf quality, improve fuel efficiency, and decrease net cost as they can decrease labour requirements.
6. Using hygrometers and/or wet/dry bulb thermometers to either automatically or manually control relative humidity in flue-curing, to minimize fuel wastage, and optimise leaf quality and yield.
7. Conserve fuel by employing the most energy efficient drying structure design and heating equipment, balancing barn (kiln) capacity and curing efficiency that maximizes throughput while maintaining the desired cured leaf quality.

5.6 Suggested Indicators

a. Percentage of growers using curing barns constructed with sustainable materials and those using hygrometers, by barn type.

6. GUIDELINES ON CURING MANAGEMENT

6.1 Context / Background

Curing is the process in which the natural, metabolic changes of ripe, fresh, harvested leaves continue under manageable conditions. Curing continues up to a stage that is considered to be optimal for producing the characteristic flavour, taste and physical properties desired in the cured product. Once the desired characteristics are reached in curing, tobacco leaves are then dried to preserve these properties. In flue- and sun-cured tobaccos the changes are arrested before all carbohydrates are hydrolysed, but in air- and fire-cured tobaccos they are allowed to continue until practically no starch and very little sugar remains.

Flue-curing requires sealed barns in which the air temperature and relative humidity can be controlled and manipulated during the curing process. Heat is generated in furnaces and transferred indirectly through heat exchanger systems that are designed to eliminate contact between the combustion by-products and the tobacco. Airflow is controlled by ventilators, and is generated as a result of natural convection created by the heating system in traditional barns, assisted by fans in modified models of these and entirely by fans in modern forced-air barns. Curing is started at around 35 °C and 85 % RH and ends at 75 °C and 10-15 % RH.

Air-curing is carried out under ambient conditions, ideally with temperatures in the range 15 °C to 32 °C and relative humidity in the range 65 % to 75 % over any 24-hour period. Air-cured tobaccos are therefore typically grown and cured in environments that naturally have these conditions during the curing phase of production. The barns can be left open when conditions are favourable but partly or fully closed when not. They can be constructed in areas with micro-climates best suited to this method of curing.

Barns for fire-cured tobacco are sealed to contain the smoke produced by open, smouldering fires in the floor of the barn. Burning is controlled to maintain temperatures suitable for the desired changes to take place but is not allowed to exceed 54 °C. Moist air is expelled through ventilators when drying the tobacco.

Sun-cured tobaccos are typically grown in hot, dry, sunny environments. Curing starts in ambient conditions, transitions to shaded conditions and then leaves are finally exposed to the sun to complete curing and to arrest the biochemical changes. Wilting and yellowing are important stages of the sun-curing process, during which the leaves gradually lose moisture and become yellow. It is important to obtain proper air circulation, heat and humidity to prevent the rapid drying of leaves, which causes them to become brown, brittle and lifeless. Yellowing typically occurs between 25 and 35 °C and 75 to 85 % relative humidity at the start of the cure. Once sufficiently wilted and yellowed, the tobacco is hung directly in the sun for drying. The methods for hanging vary by variety and growing region. In general, strings of leaves are hung on racks which are placed in such a way that they receive direct sun radiation during the day and protection from wind. Racks may be covered with sheet material to protect leaves from cooler night air. The duration of the sun-curing process is dependent upon variety, stalk position, leaf body, ripeness, and weather conditions. Sewing machines should be used with particular attention and care, as they may damage leaves or pack them too tightly, resulting in reduced leaf quality.

In terms of curing management, sustainability can be negatively impacted in nearly all tobacco types by harvesting un-ripe leaves, inadequate curing structures, incorrect application of the curing procedure for each type of tobacco, and poor handling of the cured leaf product until its sale. Curing mismanagement results in poorer leaf quality and marketability, loss of yield and, in the case of flue- and fire-cured tobaccos, inefficient energy use. Of these, loss of yield is probably the most serious, because it is not obvious and can be as high as 30 % of potential yield.

6.2 Guidelines

a. Understanding the Curing Process

Optimal cured leaf quality typically begins by harvesting ripe leaves, but ripeness at harvest is also a function of the tobacco type, style and harvest method. Some wrapper tobaccos are harvested slightly immature to produce a targeted style, and in places where whole plant stalk-cut harvest is used it is not unusual to have the lowest leaves over-ripe and the tips somewhat unripe. Under-ripe leaves have the tendency to produce a product with a greenish caste, poor texture, and a negative taste. Extending curing time does not fully compensate for under-ripe harvesting. In over-ripe leaves, much of the desirable flavour can be lost, they tend to more easily break up when handled, and they have lower yield and poorer manufacturing properties. Ripeness is judged subjectively, based on leaf colour, visual appearance, sound produced when removed from the plant, and angle at which the leaf is oriented relative to the main plant stalk. Curing requires experience and the matching of curing parameters of a given curing setup to the leaf that enters the curing process.

For correct, efficient curing management, it is important to know the principal metabolic and chemical changes that take place and how they should be controlled to produce the best product. The following description draws attention to the main processes. More detailed information should be referred to, and is provided in the references listed below.

The general curing process comprises three over-lapping phases: “colouring” (also referred to as “yellowing”), “fixing colour” (sometimes called leaf drying) and “drying” (sometimes called stem drying). The natural, metabolic changes, which started during ripening in the field, are allowed to continue in the colouring phase under the conditions provided for each type of tobacco. One of the main changes is the breakdown of carbohydrates (mainly starch) into sugars, carbon dioxide and water. Proteins and other nitrogenous compounds also break down into simpler ones. Some of them subsequently recombine with the products of carbohydrate breakdown to produce products that contribute to flavour and taste. The curing process in air- and fire-cured tobaccos allows the metabolic breakdown to continue beyond that in flue- and sun-cured tobaccos, resulting in the oxidation of polyphenols and consequent development of their characteristic brown leaf colour. In the case of dark-fire cured tobacco, an additional finishing phase may be utilized by growers. This phase is characterized by the use of additional hardwood smoke with low heat (<50 °C) to meet the desired quality of this tobacco type.

The changes are controlled by enzymes that are active while the leaves are alive. Therefore, the relative humidity in the curing environment is maintained at a sufficiently high level to avoid premature leaf cell death during the colouring phase. This will begin around 85 to 90 % RH at the start and then decreased progressively to around 60 % RH to promote wilting towards the end of this phase. Furthermore, dry-bulb temperatures are kept in the range 35 to 40 °C to provide optimal conditions for enzyme activity during the flue-curing process. Higher temperatures slow the process and could stop it completely by prematurely drying the leaves or even scalding them. In flue-cured and dark-fired tobaccos these conditions are achieved by controlling the heat and ventilation. Smoke from smouldering fires is introduced during the curing of fire-cured tobaccos and may continue until curing is complete. Air- and sun-cured tobaccos depend on prevailing weather to provide the right conditions for colouring, with any necessary moderation coming from ventilation adjustments in the case of air-cured, and by either shading the leaves or exposing them to the sun in the case of sun-cured tobaccos. Air temperature is not typically increased by supplemental heat during the colouring phase for these two tobacco types; however, in some cigar tobaccos this can occur.

In flue- and sun-cured tobaccos, the aim is to keep the leaves alive until most of the starch has broken down to sugars, minimizing the conversion of sugar to carbon dioxide. Leaves are therefore wilted in flue-curing by decreasing the relative humidity from around 85 % at the start of the cure to 60 % when they are fully coloured. This is achieved by increasing ventilation and temperature (>45 °C), which subsequently halts leaf respiration. In sun-cured tobacco, this is done by gradually exposing the leaves directly to the sun. To produce the desired degree of metabolic change and, therefore, quality in air- and dark-fired tobaccos, the colouring phase is extended by maintaining humidity at a relatively high level for longer time to permit an almost total breakdown of the starch and respiratory loss of most of the sugar. Polyphenols are oxidised under these conditions, resulting in the characteristic brown colour of these tobaccos.

Chlorophyll breaks down during the colouring phase, exposing the yellow carotenoid pigment in the leaves. This begins at the tips and margins and moves progressively towards the mid-veins. This process parallels the changes occurring with other important chemical compounds of the leaf, and serves as a visual indicator for managing the cure for best results. The yellowing process across the leaf is arrested by drying, referred to as "fixing". To avoid over-colouring and the consequent loss in quality and yield, the curing process is managed in flue-cured and most sun-cured tobaccos is managed to ensure that the drying front closely follows the progression of yellowing. This is achieved by progressively decreasing the relative air humidity, causing the previously turgid leaves first to wilt, while remaining biologically active, and then to dry further. Premature drying stops the biochemical changes important for aroma and taste too soon and can also set the leaf colour green, thus lowering the leaf quality. Colour fixing occurs earlier in flue-cured and sun-cured tobaccos than in air- and fire-cured, where the colouring process is extended to enable the biological processes to continue further.

To preserve the leaves, drying continues until the leaf lamina are completely dry and then the mid-veins. In flue-cured tobacco this is achieved by gradually increasing the temperature to 75 °C; for sun-cured by continued exposure to the sun and for air-cured by continued ventilation, occasionally supplemented by low heat in some tobacco-growing regions. In fire-curing, exposure to smoke continues throughout drying and during subsequent conditioning to "finish" the leaves.

As a general guide, the curing cycle (duration) for flue-cured tobacco from yellowing (start) to stem (final) drying should not exceed 168 hours. However, the cure duration can be extended 24 to 48 hours, depending on multiple factors that include the barn and heating system design, green leaf loading capacity, ambient conditions and agronomic factors. Curing times for air-, sun- and dark fire-cured tobaccos are much longer and vary from one situation to another, depending on the curing environment. Unnecessarily long curing cycles result in poorer quality, loss in yield from over-colouring and inefficient use of energy for types requiring heat for curing. These are the result of one or more of the following:

- Harvesting of un-ripe leaves or a mixture of ripe and un-ripe leaves.
- Temperature below the optimal for colouring (35 - 40 °C) during the colouring phase.
- Mass of tobacco in the barn is too large in relation to the capacity of the system to remove moisture.
- Leaves not loaded uniformly in the containers or tied uniformly.
- Racks or boxes not fitting tightly in bulk-curing systems. Sticks or strings not packed uniformly in traditional barns. This results in air by-passing some of the leaves, leaving wet spots where leaves over-colour and typically will take longer to dry, if at all.
- Poor curing management.

b. Common curing issues

i. Flue-cured tobacco

- Green, is commonly a result of harvesting and/or "fixing" colour prematurely. It can also be caused by scalding from radiant heat from very hot flues early in the cure.
- Slate grey, usually uniform, discolouration especially in mid- and upper-stalk leaves. This is typically in tobacco that ripened slowly and accumulated large amounts of carbohydrates; for example, in crops that run out of nitrogen prematurely or irrigated crops grown in conditions where days are hot and dry and nights cool during ripening. Such conditions favour carbohydrate accumulation. In these crops, there tends to be a premature loss of chlorophyll, giving a false appearance of ripening and later, colouring. The cured leaves typically have a "thick", soapy feel and their smoke flavour has a metallic after taste. Delaying harvesting to a more advanced stage of ripeness and then also extending the colouring period, can significantly improve the quality in this style of tobacco, although it results in some loss of yield.
- Sponge, a grey-brown, often mottled, discolouration in potentially good quality leaf, associated with over-colouring as a result of increasing temperature above 40 °C when leaf still contains a lot of moisture. Typically found in leaf from over-packed or unevenly packed barns.
- Scald, red/brownish discolouration resulting from a too rapid increase in temperature during lamina drying or exceeding 75 °C during final drying. Sugars are caramelised, imparting an off-type, sweet aroma.
- Browning, oxidation of polyphenols when over-colouring. Typical in leaf from over-fertilised crops, especially that from the lower stalk. This discolouration is not desirable in flue-cured tobacco but is, of course, in most air-cured tobaccos.
- Barn rot can be caused by a number of fungal and bacterial pathogens that thrive in high humidity conditions, especially in the 35°-40 °C temperature range. Control by ensuring that all harvesting and curing equipment and facilities are not contaminated, ensuring that the curing barn is loaded uniformly, then avoid long colouring periods by harvesting only ripe leaves, not mixing ripe with un-ripe leaves and ensuring that drying starts as soon as possible after colouring commences. In addition, the harvesting of dry tobacco whereby the leaf surface is free of dew, rain or irrigation moisture will help. If there is difficulty in implementing these precautions, avoid the temperature range at which these pathogens are most active (35°-40 °C) by colouring at less than 35 °C, commencing drying at the same temperature and then increasing temperature as rapidly as possible to 45 °C, after which the normal schedule should be followed.

ii. Air-cured tobaccos

- Green, associated with low temperatures during the colouring phase. It can also be linked with a combination of high temperatures, low RH and excessive air flow (wind) during the first stage of curing. In some tobacco types, it is caused by sunscald (sunburn) and/or physical damage (bruising), although this is typically random leaves and nor the entire leaf nor the entire barn of tobacco.
- Variegated, K-style, caused by periods of low humidity during the colouring phase and consequently premature fixing of colour. If temperatures are warm, leaf colour, although variegated, is usually bright and when cool, it is more of a green colour.

- Barn rot (house burn) is caused by infections of pathogens which thrive under high moisture conditions and the resulting prolonged colouring phase. It is more prevalent in unevenly and over-packed barns where air movement is restricted.

iii. Fire-cured tobacco

- Green, associated with low temperatures during the colouring phase. It can also be linked with a combination of high temperatures, low RH and excessive air flow (wind) during the first stage of curing. In some tobacco types, it is caused by sunscald (sunburn) and/or physical damage (bruising), although this is typically random leaves and nor the entire leaf nor the entire barn of tobacco.
- Scalding, leaf exposed to drying conditions during wilting after harvest but prior to the initiation of hanging/curing in the barn. Scalding occurs when the tobacco is stalk-cut and transpiration leads to the complete loss of water in the plant cell, thus causing it to rupture. It may also occur with excessive heat from the curing fire, which are typically a result of hot-spots that affect a portion of the tobacco within the barn.
- House burn ("strutting", "sweating"), arises restricted air movement through tobacco as a result of uneven packing; especially prevalent in wet seasons.
- Premature drying, associated with low ambient temperature (<16 °C) during curing and identified by discolouration of cured product.
- Undesirable (unspecified) discolouration, associated with barn temperature exceeding 60 °C during early curing phases prior to leaf drying.

iv. Sun-cured tobacco

- Green occurs as a result of harvesting immature tobacco or halting the yellowing process prematurely.
- Reduced elasticity and shine are a result of harvesting over-ripe leaves.
- Brown, brittle, lifeless as a result of premature drying during colouring (too hot and dry).
- Rot caused by insufficient air circulation during colouring as result of packing that is too dense, poor location of racks during colouring, and insufficient ventilation.

c. Tobacco Specific Nitrosamines (TSNAs)

i. Flue-cured tobacco

TSNAs, specifically NNK (4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone), are generally at low concentrations in flue-cured tobacco but increase significantly when the combustion by-products, specifically nitrogen oxides, come into contact with the green tobacco during the curing process. This is the case for any conventional hydrocarbon or biomass fuel used. They can also form when leaf is over-conditioned, densely packed and stored in damp, unventilated conditions.

ii. Air-cured tobacco

The most prevalent TSNA in Burley and dark air-cured tobaccos is *N*'-nitrosonornicotine (NNN). It forms mainly during the late yellowing and early browning phases of curing. NNN is formed primarily by the reaction of nitrates/nitrites/nitrogen species with the alkaloid nornicotine. Nornicotine is primarily formed by the demethylation of nicotine, a genetically inherited trait. Both the alkaloid (nornicotine in the case of these tobaccos) and the nitrosating agent (nitrite) are necessary for the formation of TSNAs. Any practice or conditions that increases the accumulation of either of these two groups of compounds can be expected to increase TSNAs. Formation is a complex process but can be minimised during the curing process by adopting all of the following practices, as far as is practical:

- Except where another variety is absolutely necessary because of its disease resistance, use only seed of varieties that have been screened for the trait that controls nicotine conversion to nornicotine or “LC” (low conversion),
- Avoid excessively high rates of nitrogen and follow recommendations for only applying side-dressing early on in the growth cycle,
- Avoid use of muriate of potash (potassium chloride), as it promotes production of fat stems that are difficult to dry promptly,
- Follow recommendations regarding time and height of topping,
- Harvest at the stage of ripeness that is optimal for yield and quality,
- Fill barns as soon as possible after harvesting,
- Do not harvest or fill barns with free moisture on the leaves,
- Site barns in micro-environments most suited for good curing,
- Space plants evenly on sticks in barns, and do not over-pack barns,
- Manage air-curing carefully to ensure adequate ventilation for timely wilting and subsequent drying of leaves without compromising quality by drying prematurely,
- Condition cured leaves naturally and avoid over-conditioning,
- Strip, grade, bale and deliver tobacco as soon as possible after curing,
- Do not put tobacco with a high moisture content in storage.

iii. Fire-cured tobacco

- space plants evenly on sticks and place sticks evenly on rails
- avoid over-packing the barn
- do not fire tobacco more than is necessary for the buyer
- start firing as soon into the yellowing phase as possible, as early as 3 days after housing but not more than 7 days after housing
- do not exceed 54 °C at any point during fire-curing
- do not maintain temperatures at or near 54 °C for longer than 4 to 5 days
- natural conditioning/ordering after curing is preferred when possible to allow takedown from the barn, or use minimal artificial conditioning

d. Moisture addition after curing

All tobacco types need moisture in the cured leaf (also referred to as bringing into order or case) to enable subsequent handling after curing for market preparation. This is an important process and, as such, is managed carefully. Tobacco in too low order is brittle and subject to significant losses, whereas that in too high order is likely to darken and decay, resulting in serious loss in value and yield of usable tobacco. As a general rule, the moisture content of flue- and sun-cured tobaccos is increased to approximately 16 % and air-cured to 18 – 23 % wet basis. Cured leaves are stored in conditions that are not conducive to spoiling and not under unnecessarily high pressure, which accelerates spoiling.

6.3 Suggested Indicators

a. **Fuel consumption** Amount of fuel per kg of cured leaf in the case of flue-cured tobacco and quantity of wood for producing heat and smoke in fire-cured tobacco.

b. **Length of curing cycle** (hours).

c. **Cured leaf quality** measured subjectively, or by an index and percentage of leaf spoiled by curing faults, of which the following are the most common:

   i. **Flue-cured tobacco**

      Green

      Slate

      Sponge, packed Scaldroma

      Browning, Barn rot

   ii. **Air-cured tobaccos**

      Green

      Variegated, K-style

      Barn rot (houseburn)

   iii. **Fire-cured tobacco**

      Scalding("bluing")

      Houseburn ("strutting", "sweating")

      Premature drying

      Undesirable (unspecified) discolouration

   iv. **Sun-cured tobacco**

      Brown

      Brittle

      Lifeless

      Rot

      Green

      Over-ripeness

      Green network (Turkish script)

d. **Concentration of tobacco specific nitrosamines (TSNAs)**

6.4 Best Practice

a. **Key requirements:**

   i. Select the curing system that can best provide the curing conditions for the particular type of tobacco, using locally available construction material from renewable resources as far as possible, and can be managed in the most labour and cost-efficient way. In addition, for flue-curing, the curing system is designed to use fuel in the most efficient manner and, for air-curing, the barn is located in the micro-climate that most closely provides the ideal conditions for natural curing.

ii. Estimating as closely as possible the ratio of curing space per unit of production that is optimal for commercial viability, taking into account the potential losses that would be incurred by having to discard ripe leaf or by over-colouring caused by over-packing curing systems.

iii. Harvesting only uniformly ripe leaves in the case of leaf-harvesting systems, and at a stage that is optimal for yield and overall quality in the case of stalk-cutting.

iv. Filling curing facilities as soon as possible after harvesting to minimise losses from scald in hot, dry weather and excessive wetting from rain or dew that adds to the moisture load in the barns and could delay timely drying.

v. Maintaining curing systems in good order and, where used, ensuring all instrumentation is accurate and fully functional.

vi. Ensuring uniform air-flow through the tobacco by uniform loading, tying and filling of curing space, especially avoiding structural leads through which air can bypass the tobacco in fan-assisted or forced-air systems.

vii. Understanding the basic curing principles for different types of tobacco and implementing them to the best advantage.

viii. Applying a curing schedule that provides optimal temperature during colouring and is capable of ensuring timely removal of moisture in line with the curing principles previously described. In fire-cured, controlling smoke and heat generation to best achieve the quality standards required for this type of tobacco.

ix. Use hygrometers and thermometers, placed in the air flow to measure temperature and relative humidity more accurately, rather than subjectively judging the actual curing conditions. It is imperative to measure the curing conditions accurately to ensure the recommended curing environment is maintained.

x. Inspecting the results of each cure, assessing its quality and identifying any visible faults. Using the information to gain experience and adjust subsequent harvesting and curing management.

xi. Avoiding excessive moisture during conditioning and storage, as well as packing and storing at too high a density.

This places an onus on members of the supply chain, as well as on the state, local and industry organizations involved in the leaf tobacco sector, to provide instruction and training in all aspects of curing, to monitor progress and to provide on-going extension support.

6.5 Additional Information

1. NC State University: Curing and Mechanization
2. University of Georgia: Harvesting and Curing Guide
3. University of Kentucky: Harvesting, Curing, Market Preparation, and TSNA Management
4. Virginia Tech University: Curing Management Guide
5. Zimbabwe Tobacco Research Board: Barn Designs and Types

7. CURING WASTE MANAGEMENT

7.1 Context / Background

The majority of leaf tobacco produced today is cured, either through air/sun curing or by adding heat, as in the case of Flue-Cured Virginia (FCV) and dark-fire cured varieties. Various energy sources are currently used for curing, and a selection is shown below.

Currently used energy sources for tobacco curing:

- Common sources: kerosene, natural gas, liquid propane gas (LPG), methane, electricity, coal, diesel, wood (waste (chips, sawdust, slats, stumps, branches), native and exotic species), local biomass (e.g.: manure – India; olive pits – Greece; peach pits – Spain; groundnut hulls – Zambia; rice straw – Bangladesh); palm oil kernel shells (POKS)- Indonesia
- Alternative / experimental energy sources: solar (solar assisted Long Sun Barn), wind, wood or biomass-fired hot water heat storage and transfer

All of the common energy sources produce varying amounts of harmful solid residues or/and gaseous emissions during the combustion process. The most sustainable practice in the context of waste management would be for waste and emissions to be avoided or reduced whenever possible, or that processes with minimum emissions be used.

Biomass, a renewable and low Greenhouse Gas (GHG) producing energy source, may be preferred from a waste and emissions point of view, but it faces its own challenges. Wood production should follow sustainable practices. In the case of electrical energy being used for curing, environmental impact may occur when it is produced from conventional sources. Electrical energy from renewable sources (i.e. photovoltaic or hydroelectric) should be considered when available and cost-effective, due to their lower propensity of GHG emissions.

Industry should develop locally appropriate best practices in each region and encourage adoption by growers of measures to significantly improve fuel efficiency (and therefore less residues and reduced GHG emissions), while incrementally reducing the labour needs of farmers and increasing their net income.

The key objectives of the guidelines on waste management (together with other sections) are to facilitate tobacco companies in:

- Identifying the combination of locally available energy sources that provides the highest level of sustainability from the farmer point of view, environment and community.
- Developing and implementing locally appropriate strategies for addressing the selection of practices to ensure sustainable fuel waste management.
- Consequently developing practices for reducing the amount of directly (Scope 1) and indirectly (Scope 2) burned fuel, to reduce GHG emissions.

7.2 Guidelines

1. The required energy input per kg of tobacco should be minimized, and based on a set benchmark. This consequently reduces the amount of waste and emissions.
2. The disposal of burnt material and its emissions should be:
   a. Locally appropriate and in compliance with local laws and regulations;
   b. Economically viable for the farmer;
   c. Not harmful to the environment.

3. Greenhouse Gas (GHG) emissions:

   A standardized reporting system for Greenhouse Gas emissions from curing, for a given amount of tobacco, should be established, with the results monitored and emissions minimised. Emissions of GHG should therefore be reduced to a given benchmark.

4. Waste from curing processes is heavily dependent on the nature of the energy source and local conditions. Appropriate disposal practices should be developed depending on the type of material.

7.3 Suggested Indicators

a. Waste from curing processes measured and action planned/in place to reduce.

b. Percentage of farmers practising appropriate disposal practices for any waste materials produced.

c. GHG emissions monitored, plans to reduce established and reduction thresholds set.

d. Percentage of farmers aware of potential causes of pollution from curing fuel consumption and proper waste disposal methods, related to energy source use and reduction.

7.4 Best Practice

1. Waste disposal

Ash from wood or dry plant material: The physical and chemical properties of wood ash vary significantly and are based on many factors. On average, the burning of wood results in about 3-10 % ash, depending on the location. When ash is produced, the combustion temperature (depending on the moisture content of the wood), cleanliness of the wood fuel, collection location, and the process itself, can have profound effects on the nature of the ash material. Wood ash composition, therefore, can vary significantly depending on the geographical location and processes. Ash is composed of many elements needed by the tree for growth. Since most of these elements are extracted from the soil and atmosphere during the growth cycle of the tree, they are common elements in our environment and are also essential elements in the production of crops and animal feed.

Calcium is the most abundant element in wood ash and gives the ash chemical and nutritive properties that are similar to agricultural lime. Ash is also a good source of potassium, phosphorus, magnesium, and aluminium. In terms of commercial fertilizer, average wood ash would probably be about 0-1-3 (N-P-K). In addition to these macronutrients, wood ash is also a good source of many micronutrients that are needed in trace amounts for good plant growth. Wood ash contains only a few elements that pose environmental problems. Heavy metal concentrations are typically low and not in a highly extractable or available form.

Coal ash: Coal ash is often used for road construction and dry landfill. Coal ash can also be used in concrete as a partial substitute for Portland cement.

2. GHG Emissions

Biomass vs. Fossil Fuel sources: In addition to fossil fuels such as coal, petroleum (i.e. oil), and natural gas, fuels can also be produced from biomass or plant materials (e.g., wood, crop residues and plant starches). The chemical composition and fundamental combustion process for biomass fuels are similar to that of fossil fuels. However, the origin of the carbon in the two types of fuels is different. Carbon in biomass is of a biogenic origin – meaning that it was recently contained in living tissue – while carbon in fossil fuels has been trapped in geological formations for millennia. Because of their biogenic origin, CO_2 emissions from biomass fuels are treated differently from fossil fuel combustion emissions. Ultimately, biomass fuel sources should be used where they are widely available, economical, and sustainable sourced.

8. SUSTAINABLE FUELS

8.1 Context / Background

A wide variety of fuel types are used to cure tobacco. The most common sources are:

- Wood biomass
- Biomass from organic waste products – coffee and rice husks, coconut shells, maize cobs, olive stones, sugar cane bagasse, palm oil kernel shells (POKS), groundnut hulls, etc.
- Charcoal
- Coal
- Natural gas, methane gas, liquid propane gas (LPG)
- Oil or kerosene
- Electricity

Alternative thermal and electrical energy sources such as solar and wind power are used on a limited basis, either as a primary or supplementary heat source, but current capital investment costs make these sources prohibitive for wide-scale use.

Most of the common energy sources for curing are stored on the farm prior to use. Proper storage management practices should be implemented to protect biomass fuel from rain and to prevent spillage of liquid fuels that could cause environmental contamination.

Selection of fuel type is generally driven by local availability and cost. Where options exist, other fuel characteristics should be evaluated to ensure that the full life cycle costs of the available fuels are weighed against any potential environmental risks, in order to make the best selections. Each fuel has its own characteristics that affect desirability from a sustainability point of view.

Considerations	Criteria
Potential costs	Transport cost from supplier to farm
	Material cost at farm
	Waste transport and disposal costs
Calorific value	Heat output per quantity of fuel
Environmental	Air pollutants from fuel combustion
	Greenhouse Gas (GHG) emissions
	Waste residue disposal or reuse
	Renewable source

8.2 Guiding Principles

Available fuel sources should be fully evaluated and selected based on the lowest environmental risk that is economically viable. This evaluation should include objective weighting of individual criteria.

Coal should only be used where no other economically viable and renewable fuels are available, due to high emission levels of air pollutants and GHGs. It should only be used as a stopgap measure while sources of renewable fuels with a much lower environmental impact are established and made available locally.

Industry, government, NGO, and all related stakeholders collaboration toward large scale production of sustainable sources of environmentally friendly fuels is encouraged to provide faster progress toward a common goal. In many countries, quantities of fuel consumed for domestic cooking fuel far outweigh the quantities consumed for tobacco curing, but there is competition for the same fuel. In these cases, in particular, the pressure on existing fuel supplies should ensure that consideration is given to developing alternative fuel types that can support local requirements.

8.3 Suggested Indicators

a. Percent of renewable fuel consumed for tobacco curing

b. Percent of alternative fuel (biomass) consumed for tobacco curing

c. Percent of wood fuel from a sustainably managed source and consumed for tobacco curing

d. Percent of electrical versus heat energy consumed during a curing cycle

8.4 Additional Information

1. ECN Phyllis Classification for Fuel Source Energy Composition
2. European Union Calorific Value Convertor
3. Food & Agriculture Organization of the United Nations: Sustainable Woodfuel for Food Security – A Smart Choice: Green, Renewable, and Affordable
4. The Engineering Toolbox: Combustion of Fuels – Carbon Dioxide Emission
5. The Intergovernmental Panel on Climate Change: Climate Change 2023 Synthesis Report
6. United States Department of Agriculture – National Institute of Food and Agriculture: Wood Energy Basics
7. United States Environmental Protection Agency: Sources of Greenhouse Gas Emissions

9. INTRODUCTION TO SOCIO-ECONOMIC ISSUES

9.1 Context / Background

The continuous development of social consciousness and standards has prompted CORESTA to take a fresh approach to the way GAP Guidelines address the relationship between tobacco organizations and tobacco growers. This relationship can have an impact on the social and economic conditions of the farm and is based on the services arising from applied and validated research that tobacco organizations can provide to tobacco growers in the improvement of these conditions. It is vital for the long-term viability of tobacco leaf production that Good Agricultural Practices should not only be environmentally sustainable, but also economically viable, socially acceptable and fully compliant with local, national and international legislation.

Many economic activities, including tobacco leaf production, involve the use of different types of capital (human, social, natural, financial and physical) to produce goods, and the use of services to satisfy the needs of people and enhance their livelihoods. A livelihood comprises the capabilities, assets and activities required to make a living. A livelihood is sustainable when it can cope with, and recover from, stresses and shocks, and maintain or enhance its capabilities and assets without undermining the natural resource base.

This dimension of livelihood sustainability is directly linked to the fulfilment of the needs of farmers and farm workers. Social and environmental sustainability is supported by efficient and effective enterprises, and that is why economic sustainability has been included as a sustainability dimension.

Ideally, any successful enterprise, whether it is a tobacco company, large estate or small farm, should be able to pay its debts, generate a positive cash flow and adequately remunerate owners and employees. To be considered as economically sustainable, the enterprise should be able to maintain these capabilities under economic, social and environmental pressure, so as to minimise vulnerability and ensure resilience.

Social sustainability is the satisfaction of basic human needs and the provision of the right and freedom to seek to satisfy the aspirations of individuals for a better life. This applies if fulfilment of an individual’s needs does not compromise the ability of others, or of future generations, to do the same. Organizations are responsible for respecting human rights, not only in their own business activities, but also in their business relationships with farmers, and supporting farmers in doing the same with their own workers.

While the first version of the social sustainability GAP Guidelines covered only training for farmers/growers and general socio-economic issues, this updated version includes the following issues:

- capacity building
- farmers’/growers’ return
- access to credit
- land tenure

Furthermore, this section of the GAP Guidelines better explains the institutional context of leaf production considers existing codes, practices and guidelines in agriculture and, more specifically, in the tobacco sector.

10. LAND TENURE

10.1 Context / Background

Sustainable tobacco growing requires long-term investments, such as in good quality curing barns and woodlots, which farmers may not be willing to undertake if there is a risk that they will not have access to the land long enough to make it financially worthwhile. Other investments may include, among others, irrigation infrastructure, land management through terracing and contouring and soil fertility improvement. Land access and tenure security influence the extent to which farmers are prepared, or able, to invest in improvements in production and sustainable land management, adopt new technologies and promising innovations, or access finance for on-farm investment and working capital.

Tobacco production often takes place in countries where farmers do not have tenure of land, and since the full benefits of certain sustainable practices accrue over several years, securing tenure, which provides the incentive for tobacco farmers to invest in a sustainable production environment, is critical.

The way that people, communities and others gain access to land, forests and water courses is defined and regulated through systems of tenure. These tenure systems determine who can use which resources, for how long, and under what conditions. These systems may be based on written policies and laws, as well as by undocumented customs and practices. Inadequate and insecure tenure rights increase vulnerability and poverty, and can lead to conflict and environmental degradation when competing users fight for control of these resources.

The governance of tenure is a crucial element in determining if, and how, people, communities and others are able to acquire rights, and associated responsibilities, to use and control land, forests and water courses.

In order to achieve sustainable tobacco production, organizations have the responsibility of respecting human rights and legitimate tenure rights and should, therefore, act with due diligence to avoid infringing on the human rights and legitimate tenure rights of others.

Land tenure is the basis for long-term investment that enables farmers to prepare better, maintain, and improve their economic condition and achieve environmental sustainability in tobacco production. While land tenure has not been directly addressed in previous CORESTA GAP Guidelines, it is now understood that all stakeholders need to take appropriate action to enable farmers to achieve sustainability in tobacco production.

The purpose of these guidelines is to focus on the role land tenure plays in sustainable tobacco production and provide guidance on ways of addressing this complex issue.

10.2 Guidelines

Organizations should follow these guidelines in regard to land tenure. In general:

1. Organizations should acknowledge that land, forests and water courses have social, cultural, spiritual, economic, environmental and political value to indigenous peoples and other communities with traditional tenure systems. They should include appropriate risk management systems to prevent and address adverse impacts on human rights and legitimate tenure rights.

2. Organizations should identify and assess any current or potential impact on human rights and legitimate tenure rights in which they may be involved.

3. Organizations should cooperate in non-judicial mechanisms to provide remediation, where necessary, including effective operational-level grievance mechanisms when required, where they have caused, or contributed to, any adverse impact on human rights and legitimate tenure rights.
4. In specific cases, organizations should consult with indigenous peoples before initiating any project, or before adopting and implementing measures affecting the resources over which the communities have rights. Such projects should be based on an effective and meaningful consultation with indigenous peoples, through their representative institutions, in order to obtain their free, prior and informed consent under the United Nations Declaration of Rights of Indigenous Peoples and with due regard given to specific positions and understandings of individual states. Consultation and decision-making processes should be organized without intimidation and be conducted in a climate of trust.
5. Tobacco organizations should avoid infringing on or ignoring the tenure rights of others, including legitimate tenure rights that are not currently protected by law. In particular, safeguards should protect women and the vulnerable who hold subsidiary tenure rights, such as those for foraging and water access.
6. When necessary, organizations should recommend to their national authorities that their contracted farmers are given land rights or very long leases because of the long-term investments that tobacco production involves, such as the building of curing barns, planting trees, establishing irrigation infrastructure, improving soil fertility, etc.
7. Organizations should be aware of the land access of their contracted farmers.
8. Organizations should encourage growers and local communities to respect areas and activities that are important to the community, be it socially, culturally, biologically, environmentally or religiously. These must not be affected by farm activities.
9. Organizations should encourage farmers towards long-term land possession (long-term rental or ownership) after due analysis of economic viability, at the lowest possible cost.
10. When operating in countries with a lack of land tenure, organizations should be supportive of collective farmer cooperatives to promote sustainable agricultural and rural development. When undertaken with appropriate safeguards and the inclusion of smallholders and communities as beneficiaries, cooperative farming can provide development benefits through economies of scale, market discipline, and consumer accountability; large scale production has the potential to lower input cost for tobacco; improve productivity and efficiency in the use of fertilizers and water; and enable investment in innovation including applicable diversification supporting GAP principles that may be too costly for small farmers to take on.
11. Where necessary, organizations should support the identification of their contracted tobacco farms by collecting GPS data, which may assist farmers obtain land rights or long leases.
12. Organizations should engage in regular stakeholder consultation with local communities, with constructive, good faith dialogue over farmer and worker related land tenure issues.
13. Organizations should be supportive of efforts to prevent corruption regarding the traditional tenure systems of indigenous peoples and other communities through consultation, participation, and empowerment.

10.3 Suggested Indicators

a. The percentage of contracted tobacco producers, in any country, who farm owned land, land on a long lease or on communal land.

b. Existence of a mechanism to assess if tobacco is grown on the traditional or sacred land of local communities.

c. Number of grievances from local communities regarding the use of land for tobacco.

10.4 Additional Information

1. Food and Agriculture Organization of the United Nations: Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security

11. ACCESS TO CREDIT

11.1 Context / Background

In addition to the technical input that farmers use and the technical assistance that organizations supply through their extension services, access to affordable finance is a crucial element in improving farming conditions. Together with the stability and longevity of trading relationships, access to affordable credit is crucial to small and large producers alike. Apart from purchasing crop inputs, financial credit is used by farmers to support their households during the off-season, to pay farm labour during the season, as well as for investing in other economic ventures.

Occasionally, farmers, and in particular small holders, lack the financial resources needed to purchase inputs at the optimum time, and are unable to make long-term investments in infrastructure, such as barns, farm equipment or irrigation systems, which would improve productivity and quality leading to enhanced grower returns.

Financial institutions also often view farmers as unattractive financial risks due to insufficient collateral (such as formal land title), lack of written records of past performance, input purchases, crop sales and the size of loans they request. In contrast to loans in urban settings, agricultural loans are typically paid off after the harvest, which may be eight to twelve months after the loan is accessed. This delay creates a further disincentive for financial institutions and, as a consequence, credit constrained farmers often use less inputs, invest less in better technology, forfeit yield and quality, and fail to maximise their income.

To achieve sustainable farming systems, it is important for tobacco farmers to have access to affordable financing and credit. In the past, access to credit has not been considered a fundamental part of the CORESTA GAP Guidelines; however, it can now be considered a limiting factor to achieving farmer sustainability – including tobacco production and other activities.

The purpose of these guidelines is to identify possible actions and mechanisms that tobacco farmers can utilise to achieve financial stability.

11.2 Guidelines

The following are guidelines to help farmers gain access to affordable credit:

1. Whenever practical and allowable under local laws, farmers directly contracted to organizations can use their signed contract as a form of collateral when discussing financing with a lending institution. This may help farmers, especially those without land tenure, to secure a loan.
2. Organizations should consider engaging with financial institutions to provide their tobacco farmers with a suitable loan package and acceptable terms.
3. Should organizations directly issue loans or credit to their contracted farmers, the terms and conditions should be agreeable to both parties.
4. Group-guarantee mechanisms can substitute as collateral requirements for a loan. Organizations may be able to facilitate the establishment of such mechanisms, and enable access to credit more easily than would be possible for individual farmers.
5. In an effort to provide equal opportunity to all growers, organizations can also assist by working with financial institutions to help them define eligibility requirements in line with the operating conditions of tobacco growers of varying size and scale.

6. Organizations could work with financial institutions on the expected production and income level to enable financial institutions to better determine the optimum size of the loan that the farmer could reasonably repay with the income from the tobacco crop sale. Over-lending should be avoided so that farmers are not burdened with unsustainable levels of debt.
7. Whenever appropriate, tobacco organizations should provide information to contracted farmers on how to access credit and use instruments and tools (e.g. financial planning) for improved financial management.
8. Accurate recordkeeping would help farmers better understand and plan for future expenses, make them more attractive financial clients, and help them identify and save any surplus income. Organizations should consider ways to foster these skills in their contracted farmers through appropriate training, thereby increasing their ability to purchase inputs and save money.
9. It is also recommended that organizations should, where appropriate and possible, develop appropriate mechanisms for the farmer to have access to cash during the season to pay for farm labour.

11.3 Suggested Indicators

a. Number of contracted farmers who have been informed about, and trained on, access to finance.

b. Percentage of contracted farmers who are part of a loan support group (where applicable).

c. Percentage of contracted farmers who have fully repaid their debt, on time.

d. Percentage of expected crop income the financial institution uses as a loan ceiling– Debt Service Ratio (where applicable).

11.4 Additional Information

1. Food and Agriculture Organization of the United Nations (FAO) – Sustainability Assessment of Food and Agricultural Systems (SAFA) Guidelines

12. FARMER RETURNS

12.1 Context / Background

Much of the leaf tobacco produced today is from developing countries, and the crop is often cultivated by small scale growers, in terms of both land holding and economic strength. Ensuring adequate farmer profitability is critical for the long-term sustainability of tobacco cultivation and, hence, farmer return is a fundamental element in sustainable tobacco production.

Paying a fair price, though important, does not in itself guarantee a good net return for the farmer. From a purely economic dimension, the farmer profitability equation depends on four factors –productivity, market-related quality, market price and production cost. Furthermore, "profitability" in itself is often a relative term and depends on other contextual factors, such as the possibility of farmers' access to affordable crop insurance. The critical challenge faced by the industry today is to address farmer profitability in an economically, socially and environmentally sustainable manner.

Farmer resilience is based on their solvency, which directly impacts their ability to purchase sufficient technical inputs, crop inputs and labour services and to invest in farm improvements. Tobacco farmers operate under very volatile conditions, which are exacerbated by unpredictable regulatory developments, lack of or limited access to crop insurance and complex market dynamics, as well as climate variability; all of these increase the uncertainty and volatility of economic and environmental conditions.

The purpose of these guidelines is to highlight the importance of resilience in leaf tobacco production, particularly in situations of economic, environmental and social pressure and to make it easier for tobacco organizations to:

- Holistically assess farmer economics, incorporating elements of environmental, social and economic sustainability.
- Develop and deploy sustainable and locally appropriate strategies for addressing farmer profitability.

12.2 Guidelines

The proposed guidelines for improvement of farmer returns are broadly categorised into three key sub-themes: (a) Guidelines for the assessment of farmer economics (b) Guidelines for the evaluation of farmer margins and (c) Guidelines for the improvement of farmer profitability.

1. **Guidelines for the assessment of farmer economics**

Organizations should follow the guidelines below for assessment of farmer economics:

a. Use appropriate procedures for capturing and archiving data on farm productivity, market price and cost of production from all contracted tobacco growers. Organizations should measure productivity, price and all production cost elements.

b. Assess production economics and farmer returns from other comparable crops grown within the same geographical area, during the crop growing season. Organizations should follow an objective process for assessment of economics and risks associated with the production of other crops comparable to tobacco.

c. Empower and support tobacco growers to comply with all relevant local laws pertaining to agriculture, applicable within the state. Organizations should inform and educate growers to comply with locally applicable laws and should include the costs involved for compliance in the production cost assessment process.

d. Ensure that prices paid to farmers take into consideration the amount of family and hired work required to grow the crop and contribute to achieving a sustainable livelihood for farmers and workers. Organizations should have a robust, transparent system to calculate cost of production, with local stakeholders' input, which takes into account all labour costs. The concept of Living Income and Living Wage should be introduced to farmer/growers and workers, respectively.

2. Guidelines for the evaluation of farmer margins

Organizations should follow the guidelines below when evaluating margins with the aim of providing farmers with a decent standard of living. Since a majority of farmers grow other crops besides tobacco, the assessment should include the whole farm as well as off-farm income sources.

a. **Know the minimum livelihood standards in the local economy.** Organizations should be aware of the minimum livelihood standards where they source their raw materials. Tobacco pricing should be reflective of this aim and organizations should formulate pricing strategies that provide a fair margin and assist contracted tobacco growers to live above the poverty line.

3. Guidelines for the improvement of farmer profitability

Organizations should follow the guidelines below for the improvement of farmer profitability.

a. **Continuously support and encourage growers to adopt sustainable tobacco farming practices in the areas of soil, water, labour, fuel and biodiversity conservation.** Organizations should develop locally appropriate best practices in each area, support adoption by growers, and include the costs incurred towards implementation in the production cost assessment process.

b. **Support growers in improving farm productivity and product quality in a sustainable manner.** Organizations should continuously work with growers towards improving their farm productivity regarding tobacco, rotational crops and diversified farm activities through quality agricultural extension services to growers and through applied and validated Research and Development of current sustainable practices.

c. **Promote farm investment.** Farmers who adopt improved technologies and adopt agricultural best practices should have sufficient disposable income to invest in farm improvements. Organizations should encourage farmers to do so and advise them on how to optimise the financial ratios of the farms.

d. **Support growers in optimising production costs incurred through agricultural inputs (seeds, chemical fertilisers, pesticides, manures, etc.).** Organizations should promote appropriate sustainable agricultural practices among growers for rationalisation of production costs of agricultural inputs in tobacco farming. Where possible, organizations should also engage with stakeholders to stabilize prices of agricultural inputs.

e. **Implement feasible farm mechanisation and labour-saving solutions for managing production costs incurred through labour.** Organizations should identify labour intensive operations and work towards dissemination of appropriate farm mechanisation or other enhancing solutions among growers.

f. **Facilitate necessary financial infrastructure and credit/insurance mechanisms for growers with the aim of lowering their investment burdens and risks.** Wherever applicable, organizations should work with local financial and non-financial institutions to facilitate credit, crop insurance and other financial instruments for growers.

g. **Improve natural resource use efficiency for growers in farming systems.** Organizations should help the growers in implementing production practices that significantly improve the farm efficiency in the use of natural resources, such as improving rain infiltration and better use of modern advanced long-range weather forecasting services, improving irrigation systems, and minimizing the use of fuel.

h. **Develop farm level approaches for tobacco growers to combat climate change.** Organizations should develop and deploy weather resilient production practices among growers to help them mitigate risks associated with climate change, such as developing drought resistant varieties, improving rain infiltration and enforcing reforestation practices where appropriate.

i. **Engage in constructive, good faith dialogue.** Organizations should engage in constructive, good faith dialogue with stakeholders (farmer associations / Organizations and trade unions) regarding production issues, with the aim of agreeing on how best to improve productivity and returns.

12.3 Suggested Indicators

a. Farmer economics:

i. Measure of the gross farm output per unit area (kg/hectare) for all tobacco growers.

ii. Farm Business Profit (FBP), also known as net return: this provides a measure of profitability over time and represents the farm cash funds available for investment and consumption after paying for all costs of production, changes in inventories and depreciation. In practice, this means the total revenue from tobacco and other farm activities, less the total cash costs for material, services, farmers’ and adult family members’ labour, hired labour, land changes, plus depreciation, and energy costs.

iii. Tobacco contribution to the farm economy: the ratio of the proportion of net income of tobacco to the proportion of its sales value in the farm economy.

iv. Percentage of farmers adopting specific sustainable agricultural practices as recommended: each local organization should identify and measure grower adoption rates of key recognized sustainability practice improvements appropriate for production practices in the origin.

v. Percentage of improvement on returns introduced by specific sustainable agricultural practice and percentage of farmers adopting it.

vi. Percentage of farmers having access to banking and other financial services (bank accounts, loans, insurance, etc.).

vii. Average number of household members (including the farmer and their direct dependents, but excluding hired labour).

b. Farmer margins

i. Annual household income stream: This indicator assumes that the more economic secure a household is, the greater its annual cash income stream. This includes both cash and in-kind income. Cash income includes income from other crops, from other labour jobs, and other sources. In-kind income is the income a household receives from crops grown but not sold for cash and may be recognized and documented within the specific country’s Employment Acts. The underlying concept behind this is that these crops have either a food value, or some other value, to households and, because they grew them, they do not have to be purchased.

ii. Crop input value pre-financed by contracted buyers, expressed as percentage of the expected tobacco value at point of sales.

iii. Level of tobacco debt repayment by growers at the end of the season.

iv. Returns above Variable Cost: Returns above variable costs helps gauge the potential profitability of a farming operation and assists growers in evaluating alternative strategies for getting the most out of their land, capital and labour. Variable costs are cash expenses paid for inputs unique to tobacco crop; including seed, fertilisers, CPAs, fuel, and labour.

c. Farmer profitability

i. Percentage of farmers covered by extension services and research and development, to help them adopt current sustainable practices for cultivating tobacco.

ii. Profit margin as percentage of the total cost of production.

iii. Percentage of farmers who adopted a farm mechanization solution in labour intensive operations, adopted new practices which bring about a reduction in man hours and/or improved efficiencies in any stage of tobacco cultivation.

iv. Existence of an action plan to help farmers improve on these indicators.

12.4 Additional Information

1. International Federation of Red Cross and Red Crescent Societies (IFRC): Guidelines for Livelihoods Programming

13. CAPACITY BUILDING

13.1 Context / Background

Farming, including tobacco production, requires several skills to be successful and sustainable. Farmers deal with and respond to increasing pressure caused by regulatory requirements, labour laws, limited resources, climate change, the need to manage the environment well, and in some cases with poor enabling infrastructure. In addition to tobacco, other crops are grown either to support sustainable tobacco production by providing fuel or to complement tobacco in a rotation according to good agricultural practices and to provide an additional source of income to the farmer.

Organizations should do their best to support farmers and the communities in which they operate, by providing technical advice through effective extension service delivery and transfer of know-how in regular sessions of training using the most appropriate means, systems and venues, by developing the amount of local business and by helping improve local infrastructure.

Since agricultural work, including tobacco production, is very strenuous, organizations should be encouraged to help farmers find economically viable labour-saving techniques.

Capacity building should, in the end, help farmers become more efficient and earn better revenues through increased crop production and crop diversification in a sustainable way.

13.2 Guidelines

1. Training

These guidelines aim to support organizations to address capacity building through training and to limit the risk of monoculture dependence through the increase of efficiency and returns that training achieves. Organizations should be encouraged to:

a. Have a well-trained network of field technicians who can transfer know-how to farmers through training sessions, demonstration days, regularly scheduled farm visits and other means suitable to the local circumstances.

b. Provide all field technicians not only with regular training but also with the technical instruments to fulfil their work, such as adequate means of transport and IT and educational materials.

c. Assess the level of knowledge and literacy of farmers before providing the training.

d. Identify existing strengths and weaknesses of growers and tailor training to accommodate these development needs.

e. Deliver and record the training of farmers/growers, farm employees and workers on sustainable agricultural practices through media that are within the grasp of average local farmers.

f. Verify the effectiveness of the training through monitoring.

g. Seek the views of farmers over their ability to produce the crop following the training provided, and assist them to meet their concerns.

h. Provide information to farmers using various methods e.g. extension leaflets, bulletins, stakeholder meeting, shows and radio programs.

i. In the case of smallholder farmers in developing countries, provide an interactive mode of communication supported by sequence of displays, which includes photographs, posters on good agricultural practices to be put up across the villages.

j. Encourage and organize reporting of issues and set up a clear communication channel that is bottom-up for the farmers to report their issues and get assistance to address these issues in the shortest timeline, and identify the referent person that is closest or more accessible from their farm.

2. Community investment

These guidelines aim to help organizations maximize the reach of the economic benefits of crop production to local communities. Organizations should consider to:

a. Where feasible, keep as many activities related to crop production, such as sourcing of inputs, processing, training of staff, in the country in order to maximise the creation of local value through employment at all levels of qualification, investment, marketing and tax payments.

b. Recruit permanent and temporary personnel from local communities, thus contributing to the build-up of sustainable livelihoods.

c. Be active members in their community and engage and consult with local government, schools, local organizations, non-governmental organizations on the needs of the community.

d. Collaborate with the local community on aspects of protection of the environment and improvement of health and safety linked to crop production.

e. Where appropriate, promote education among rural communities by supporting the local schools through building classrooms, toilets and teaching staff accommodation, thereby reducing school drop-outs.

f. Where appropriate, promote education through scholarship which gives access to different levels and fields of education, leading local youths to take part in diversified jobs which are necessary for the entire community.

g. Where wood is used in tobacco growing, encourage wasteland development to grow high quality timber as viable cash crops and other local species that meets fuel, domestic fodder and nutrition requirements.

h. Where appropriate, work towards conservation, development/rehabilitation and sustainable management of natural resources like tanks, ponds, feeder channels and other water bodies like springs and streams with the full involvement of communities for soil and water conservation.

i. Where appropriate, support the upgrading of livestock among farmers as a way to provide an additional viable livelihood opportunity.

3. Labour-saving techniques

These guidelines aim to support tobacco organizations to address the issues pertaining to labour shortage. Organizations should consider to:

a. Promote labour-saving technologies that take into consideration cost, maintenance, upkeep and farmer needs in the design.

b. Promote improved practices and agricultural conservation techniques that reduce the intensity of labour requirements in land preparation, transplanting, weeding, pest control, tillage, harvest and post-harvest areas.

c. Where appropriate, work towards strengthening draft animal population in the villages to enable timely planting by helping the farmers in various activities, such as ridging activity, marking, cultivation and weeding.

d. Where appropriate, use agricultural extension to educate farmers on adoption of available labour-saving implements / technologies, like promoting cultivators, transplanters and fertilizer applicators.

e. Where appropriate, propagate a community level approach among farmers for adoption / availing of the highly expensive labour-saving technologies / implements

f. Where appropriate, work with local government bodies for getting subsidies to farmers on farm mechanization implements.

g. Where appropriate, promote access to viable equipment hire opportunities for small scale growers who would otherwise not have access to such opportunities or promote workable collective equipment ownership schemes.

h. Where appropriate, increase the wages at par with other jobs available locally to make agricultural jobs more attractive and remunerative.

13.3 Suggested Indicators

a. Training

i. Percentage of field technicians undergoing regular training during each year of employment.

ii. Percentage of farmers provided training on sustainability-related topics.

iii. For each subject of training, percentage of farmers who upon verification have demonstrated that they have understood the training and are applying it.

b. Community investment

i. Percentage of locally hired workforce.

ii. Ratio of value added through operations (or tax payments) to total revenue (or profit).

iii. Percentage of total revenue (or profit) invested in the regional economy.

iv. Percentage of turnover (or profit) coming from local value chain.

v. Percentage of inputs procured from the country, excluding inputs which are not locally available and which should be detailed separately.

vi. Percentage of turnover (or profit) devolved to projects for community improvement.

vii. Existence of key performance indicators demonstrating the success of the community projects.

c. Labour-saving techniques

i. Percentage of farmers trained in and implementing conservation agriculture.

ii. Number of workshops arranged to farmers on farm mechanization.

iii. Percentage of farmers who have adopted new mechanization in a particular operation in a given area.

iv. Percentage of labour-savings attained by using mechanization in a particular operation.

v. Where possible, percentage of cost reduced by collaborations with government institutions on subsidy of the cost of implements.

vi. Where appropriate, number of community group models on farm mechanization set up in the region.

vii. Difference between farmers' income level before and after adoption of labour saving technologies.

13.4 Additional Information

1. Food and Agriculture Organization of the United Nations (FAO): Sustainability Assessment of Food and Agricultural Systems (SAFA) Guidelines
2. Food and Agriculture Organization of the United Nations (FAO): TECA – Technologies and Practices for Small Agricultural Producers

14. FARM PERFORMANCE

14.1 Context / Background

In most tobacco-growing countries, agriculture is a key driver of the economy. Farms represent small or large business enterprises based on agricultural production. In countries where contracts can be put in place and with the respect due to business partners, organizations are recommended to provide farmers and, where appropriate, farmers' organizations with a sound contract which outlines expectations of both parties and takes into consideration volumes, quality, prices and social and environmental conditions.

Where feasible, tobacco organizations should encourage diversification and in doing so, could also consider means of facilitating input and advising on cultivation techniques, post-harvest handling, storage, processing, transportation and marketing. By doing so, organizations facilitate economic growth and poverty reduction by aiming at wealth creation so that benefits reach down the supply chain to small-scale producers and other vulnerable economic actors.

In addition to tobacco production, organizations should advise tobacco growers on good agricultural practices, sustainable management of resource, labour issues, income streams, and where appropriate on food security.

The size and operating conditions of tobacco farms worldwide are so different that organizations should use an inclusive approach that targets leaf quality, sustainable production and economic returns with the provision of adequate technical support.

14.2 Guidelines

These guidelines aim to support organizations to address and assess total farm performance and sustainability. Organizations should be encouraged to:

1. Have written, clear and robust contractual arrangements that are aligned by the appropriate regulatory body of the country of production, thereby ensuring alignment with farmers / farmer's organizations, wherever appropriate. Contracts should include, where applicable, quantity, quality, delivery time, prices, inputs, credits, support, environmental and social/human rights requirements, and compliance;
2. Provide contractual agreements to farmers / farmer's organizations in a timely manner, in advance of seedling production;
3. Apply contract terms which provide realistic profit expectations under normal conditions and good crop management;
4. Support the principle of continuous improvement at farm level through a regular and documented process of review of achieved results and setting of targets;
5. Monitor the impacts of farm production so that improvements can be made over time.

14.3 Suggested Indicators

a. Where applicable, existence of a written clear contract between the contractor and farmers and, where appropriate, farmers' organizations.

b. Inclusion in the contract of volume, terms and conditions of marketing, compliance, environmental and social/human rights requirements.

c. Existence of a company formalized process to review farm performance and targets for improving sustainability.

d. Existence of a process for informing farmers, about their own performance and for dealing fairly with results that need improvement.

e. Regular assessments of farms by external third parties.

14.4 Additional Information

1. Food and Agriculture Organization of the United Nations (FAO): Farm Business Analysis – Using Benchmarking
2. Food and Agriculture Organization of the United Nations (FAO): Sustainability Assessment of Food and Agriculture Systems (SAFA) Guidelines

15. STAKEHOLDER ENGAGEMENT

15.1 Context / Background

Sustainability is founded on understanding the aspirations and concerns of stakeholders, and engaging them is a way of supporting sustainability through addressing their legitimate claims.

The number of people who work in, are dependent on and are affected by agricultural production is very high. The number of potentially impacted stakeholders can also be extensive, even for a small or medium sized enterprise. While identifying, informing and empowering stakeholders is crucial, it is also a major challenge. Organizations need to ensure comprehensive stakeholder participation by addressing sustainability concerns and developing long-term solutions. Participation is equally important at all levels, for small and large farmers alike, through the sharing of knowledge and deciding fairly on issues regarding the use of family or community resources.

Tobacco farmers and their associations represent critical stakeholders and, therefore, management of these relationships needs to be transparent and take their concerns into consideration.

15.2 Guidelines

The purpose of these guidelines is to help organizations to involve relevant stakeholders on issues relating to tobacco production. Organizations should:

1. Proactively identify, empower and consider relevant stakeholders, as far as possible, in decision-making processes, including vulnerable groups and those unable to claim their rights (e.g.: nature and future generations). This may take place through working groups, forums, public meetings, bilateral negotiations;
2. Conduct engagement with legitimate stakeholders tailored to specific objectives;
3. Keep legitimate stakeholders abreast of plans, developments and alterations in crop production. In particular, organizations should notify stakeholders of any decisions arising from their feedback that specifically address raised concerns;
4. Ensure that all potentially affected stakeholders have access to appropriate grievance procedures without a risk of negative consequences;
5. Resolve conflicts of stakeholder interests through appropriate direct or mediated dialogue based on clearly defined contractual terms, respect, mutual understanding, fair conflict resolution and equal power.

15.3 Suggested Indicators

a. Existence of a thorough stakeholder mapping.

b. Existence and utilisation of a process to analyse claims, including explicit justification.

c. Existence and utilisation of procedures or instruments ensuring fair treatment for all stakeholders.

d. Existence and utilisation of procedures or instruments (e.g.: mediators) ensuring that conflict resolution is dialogue-based, not power-based.

e. Existence and utilisation of a transparent and clear process that ensures visibility and effective communication, and provides appropriate documentation for record keeping.

15.4 Additional Information

1. Food and Agriculture Organization of the United Nations: Sustainability Assessment of Food and Agriculture Systems (SAFA) Guidelines
2. United Nations Collaborative Initiative on Reducing Emissions from Deforestation and Forest Degradation (REDD) in Developing Countries: Stakeholder Engagement in REDD+

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