# Assessment of vegetable production systems in Ethiopia for the identification and promotion of sustainable agricultural practices


Wubeshet Beshir [1], Kromann Peter [2]

[1] Stichting Wageningen Research Ethiopia

[2] Wageningen University & Research-WUR



ESP working paper #001


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Ethiopian SEED PARTNERSHIP

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The working paper provides a detailed assessment of vegetable production practices in Ethiopia, emphasizing the importance of sustainable agriculture. It discusses current management practices, challenges faced by producers, and offers recommendations for sustainable agricultural practices. The study utilized various data collection methods and highlighted the significance of sustainable agriculture in addressing the needs of a growing population and climate variability. Key recommendations include implementing training programs on pest management, judicious pesticide use, integrated pest management, and soil fertility management to enhance sustainability and productivity in Ethiopian vegetable production. These measures aim to benefit farmers and promote economic growth in the sector.

Keywords: sustainable, agriculture, practices, seed, Ethiopia

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# Preface

The mission of the Ethiopian Seed Partnership (ESP) is to enable the private sector in Ethiopia to deliver farming men and women high-quality seeds of improved varieties much needed for food security nutrition, and climate resilience. The project aims to increase crop productivity and diversity and create jobs, as well as increase the area under sustainable agricultural practices. This included the improvement of women's access to finance, entrepreneurship opportunities, managerial and leadership roles, and life-long learning.

Sustainable agricultural practices are promoted by ESP through collaboration with seven international breeding companies and their local distributors, partners of the project operating in Ethiopia. These project partners are strongly engaged in showcasing and demonstrating recommended varieties, cultivation practices and production systems to farmers.

Under the leadership of Wageningen Plant Research, a descriptive document was developed in consultation with project partners that outlines ESP's definition of "Sustainability in agriculture" and outlines examples of sustainable agricultural practices (SAPs).

As part of ESP's project component about sustainability in agriculture, this report evaluates current vegetable cultivation practices in the intervention areas of the breeding companies and project partners in Ethiopia and advises on localised sustainable agricultural practices that can be promoted through the project.

**Contact:** info.ESPseedethiopia@gmail.com
**More information:** www.esp-seed.org

# List of abbreviations and acronyms

| | |
|---|---|
| ESP | Ethiopian Seed Partnership |
| CRV | Central Rift Valley |
| Horti-LIFE | Horticultural Livelihoods, Innovation and Food Safety in Ethiopia |
| KII | Key Informant Interview |
| IPM | Integrated Pest Management |
| NGO | Non-Governmental Organization |
| m a.s.l | meter above sea level |
| PHI | Pre- Harvest Interval |
| PPE | Personal Protective Equipment |
| SAPs | Sustainable Agricultural Practices |
| SNNPR | South Nations, Nationalities and Peoples Region |
| SWR | Stichting Wageningen Research |
| WCDI | Wageningen Centre for Development Innovation |
| WUR | Wageningen University & Research |

# Summary

The document "Assessment of Vegetable Production Systems in Ethiopia for the Identification and Promotion of Sustainable Agricultural Practices" provides on-the-ground assessment of vegetable production practices in Ethiopia. The study outlines current vegetable management practices in the main vegetable production areas and aims to recommend sustainable agricultural practices (SAPs) for the Ethiopia Seed Partnership (ESP) project partners and farmers.

The report presents key findings that encompass a detailed description of common cultivation practices for a variety of vegetables including tomato, onion, cabbage, and others. It also sheds light on the challenges encountered by producers and offers insightful recommendations for sustainable practices. The assessment was conducted using a range of data collection approaches such as key-informant interviews and virtual interactions, covering topics from nursery management to in-field cultivation and post-harvest practices.

A central theme underscored in the report is the significance of sustainable agriculture in addressing the needs of a burgeoning population and mitigating the effects of climate variability. It emphasises the pivotal role of promoting sustainable agricultural practices as a primary approach to boost the sustainability of vegetable farming in Ethiopia, necessitating collaboration with project partners, international breeding companies, and their local distributors.

The report's key recommendations advocate for the implementation of training programs focusing on pest and disease symptom identification, judicious and safe pesticide use, integrated pest management (IPM) practices, and soil fertility management practices involving organic soil amendments and cover crops. Additionally, the recommendations endorse soil testing, standardization of inorganic fertilizer recommendations based on economic feasibility, and conducting demonstration trials to showcase effective pest and soil fertility management strategies to growers. It is anticipated that implementing these recommendations will significantly enhance sustainability and productivity in Ethiopian vegetable production, thereby benefiting farmers and fostering economic growth within the sector.

# 1 Introduction

In addition to being an essential part of a healthy diet, vegetables are also a means of subsistence for those working in the food chain, such as farmers, traders, transporters, and processors. In this sense, vegetables play a multifaceted role in bolstering food and nutrition security, facilitating foreign exchange earnings, and significantly mitigating poverty, particularly in rural areas where agricultural activities are focal points (Dagmawe and Abdurhman, 2022).

Ethiopia has an ideal climate and edaphic conditions for the cultivation of tropical, subtropical, and temperate vegetables for both domestic and international markets in the lowlands (1500 m a.s.l.), midlands (1500-2200 m a.s.l.) and highlands (>2200 m a.s.l.) of the country, respectively (Nimona, 2020). Although Ethiopian vegetable production fluctuated substantially in recent years, it tended to increase from the year 2002 until 2021, reaching 1.65 million tons in 2021 (World Food and Agriculture - Statistical Yearbook 2021. Rome., 2021).

These days, there is a push for sustainable agriculture as a way to feed the world's growing population and mitigate the effects of climate change (Mazibuko *et al.,* 2023). Sustainable agriculture has features like it conserves resources; it is environmentally friendly, technically and economically appropriate and socially acceptable (Hailemariam *et al.,* 2013). As a result, sustainable agricultural practices (SAPs) are generally understood to include a range of techniques like conservation tillage, legume intercropping, legume crop rotations, improved crop varieties, animal manure application, improved water management, integrated pest management (IPM), biodiversity conservation, the complementary use of inorganic fertilizers, and the use of soil and stone bunds for the conservation of water and soil (Wollni *et al.*, 2010).

For the purpose of promoting SAPs in the ESP project in Ethiopia, a descriptive document was developed in consultation with ESP project partners that outlines ESP's definition of "Sustainability in agriculture" and outlines examples of SAPs (see, Annex I). The mentioned document states that "sustainable agriculture aims to maintain and improve soil health, conserve water resources, protect biodiversity, and minimize leaching and emissions of synthetic plant nutrients and greenhouse gases while strengthening resilience to climate change and enhancing the livelihoods of farmers and rural communities. This can be achieved through a variety of sustainable agricultural practices that respond to three defined dimensions of sustainability in agriculture: 1) Economic sustainability, 2) Environmental sustainability and 3) Social sustainability.

To advance the promotion of SAPs within the framework of the ESP project, an on-the-ground study was undertaken to evaluate existing vegetable production systems and prevalent current cultivation practices. This assessment serves as a benchmark for the conceptualization and implementation of potentially innovative SAPs that could be promoted and then to distribute the findings through the project partners, who will showcase and advocate for the adoption of SAPs among farmers in their outreach and within their marketing domains. Therefore, the aim of this report is to identify potential SAPs that can be demonstrated to farmers through the partnering breeding companies involved in the project.

## 1.1 Objectives

- To understand the current vegetable production practices in the marketing areas of the partnering breeding companies.
- To identify potential sustainable agricultural practices that can be demonstrated and promoted to farmers through the companies.

# 2 Methodology

## 2.1 Data collection approaches

The assessment study engaged a blend of approaches and methodologies. The first approach was a comprehensive review of available literature to determine how vegetable production in Ethiopia is perceived. Both published and unpublished grey literature were researched.

To collect information from farmers in the marketing and intervention areas of the partnering breeding companies, nineteen graduate students, hired by the companies as interns, and two ESP staff participated as enumerators. ESP organized training for the interns to make them familiar with the data collection method "Kobo Toolbox, a data collection toolkit" (https://support.kobotoolbox.org/welcome.html), which was used to collect data from interviewees.

For further data collection and additional sources of information, the project assessment team also employed key-informant interviews (KII) on the challenges of the sector and key issues related to currently employed agricultural practices and cultivation systems, which producers are applying to produce vegetables. While conducting the KII, the team employed both face-to-face and in cases where it was not possible to hold face-to-face discussions with some of the target group representatives, virtual online interviews were held.

A total of 82 respondents including farmers, extension workers (both *kebele* and district levels), commercial seedling producers and representatives from companies were involved in the process (**Error! Reference source not found.**).

***Table 1. Summary of interviewees contacted throughout the assessment***

| Contacted interviewee | Quantity (in number) | Remarks |
|---|---|---|
| Company representative | 4 | Two are female |
| Farmer | 35 | Two are female |
| Extension worker | 41 | 26 at *Kebele* and 15 at district level (4 are female) |
| Manager of commercial seedling producer | 2 | Representatives from Joy Tech and Ethio-flora |
| **Total** | **82** | |

The data collection was aimed at various vegetable growing locations connected to the marketing areas of the partnering companies. However, a subset of interns deployed in these locations faced challenges adhering to the prescribed data collection procedures, particularly related to the KOBO Toolbox method and displayed limited motivation to participate in interviews and data-gathering activities. It became apparent that certain interns perceived data collection as a supplementary task devoid of incentives. Consequently, incomplete KOBO datasets were predominantly reported, notably from the Somali and Central Ethiopia regions.

This situation presented substantial challenges in collecting comprehensive datasets from representative producer groups across the data collection locations, thereby limiting the ability to draw accurate and region- or location-specific conclusions about farming systems. Nonetheless, efforts were undertaken to mitigate these challenges by engaging key informants where possible. This enabled the reporting of valuable information, albeit somewhat constrained, providing an overview of vegetable production across the areas where the companies promote their products. This differed from the initially anticipated quantitative assessment by specific locations.

## 2.2 Study locations

For the assessment, potential vegetable producing areas of the country were selected purposively by following the marketing routes of the companies and focusing on areas where the companies are demonstrating and promoting their improved vegetable seeds. Accordingly, the following locations were selected for data collection: 14 *kebele*s from 8 *woreda*s (Adami Tullu and Jido Kombolcha, Dugda, Ada`a, Bora, Adama zuria, Lume, Kersa and Chiro town) in Oromia region, 4 *kebele*s from 3 *woreda*s (Termaber, Bahirdar zuria and Mecha) in Amhara region, 2 *kebele*s from 2 *woreda*s (Wondo genet and Shebedino) in Sidama region, 3 *kebele*s from 1 *woreda* (Arba minch zuria) in South Ethiopia region, 1 *kebele* from 1 *woreda* (Mareko) in Central Ethiopia region, 1 *kebele* from 1 *woreda* (Gode) in Somali region and 1 *kebele* from 1 *woreda* (Erer) in Harari region.

## 2.3 Information synthesis and presentation of key findings

Qualitative and quantitative information gathered from the desk review and interviews was synthesized using content and thematic analysis techniques and divided into sections depending on the nature of the contents.

The following sections of the report are structured in sub-sections following the suit of thematic orders. The first section, section 3.1. describes the key findings related to the types of commonly cultivated vegetable crops. Sections 3.2 to 3.7 describe key findings related to the following vegetable management practices: nursery management and source of planting materials; field preparation; spacing and plant population; irrigation management; fertilizer management; and pest management. Section 4 presents the key challenges identified by vegetable producers. Finally, Section 5 presents potential SAPs recommended for validation, enhancement, and promotion by partnering breeding companies to farmers through demonstration plots.

# 3 Key findings

## 3.1 Commonly cultivated vegetable crops

Based on our assessment, it was observed that in the majority of marketing areas of seed companies, the commonly cultivated vegetables by farmers and other producers include tomato, onion, cabbage, kale (Ethiopian cabbage), hot pepper, chilli pepper, sweet pepper, carrot, lettuce, beetroot, watermelon, and cucumber. These vegetables are cultivated both during the rainy and irrigation seasons, albeit to varying degrees of production.

In terms of varieties, there is a growing trend of utilizing hybrid varieties over time, driven by farmers' awareness of the advantages offered by hybrids compared to open-pollinated varieties of respective crops. These advantages include higher yields, enhanced resistance to pests, and improved quality for sales.

***Table 2. Comparative advantages of hybrid varieties over Open pollinated varieties (OPV) for commonly grown vegetables in Ethiopia***

***Source:*** *Crop Variety Register,2021*

| Crop | Yield (qt/ha) | | Days to maturity | | Remarks |
|---|---|---|---|---|---|
| | Hybrid | OPV | Hybrid | OPV | |
| Tomato | 357-1016.40 | 276-463 | | | |
| Onion | 369-750 | 300-400 | 70-105 | 90-142 | |
| Hot pepper | up to 681.60 | up to 206 | 80 | 100 | Green pod |
| Cabbage | 320-1270 | 300-400 | 65-90 | 90-110 | |

***Table 3. Productivity ranges of selected crops at farmers` field***

| S.NO. | Crop Type | Average Productivity (ton $ha^{-1}$) |
|---|---|---|
| 1. | Tomato | 17.50-85.00 |
| 2. | Onion | 15.00-65.00 |
| 3. | Hot pepper | 26.80-30.00 |
| 4. | Cabbage | 17.50-45.00 |
| 5. | Watermelon | 15.00-25.80 |

## 3.2 Nursery management and source of planting materials

Farmers situated in the Central Rift Valley (CRV) areas primarily obtain seedlings from commercial seedling producers such as Ethio-flora, Joy Tech, and Roshland, especially for tomato and hot pepper, and occasionally for cabbage and onion. In these areas, many vegetable producers place direct orders for the required quantity of seedlings to seedling producer companies. Alternatively, some producers also purchase the seeds by their own and engage the companies to raise the required seedlings.

However, for other vegetables and producers situated far from commercial seedling producer companies, the predominant practice involves purchasing seeds from various sources and raising seedlings themselves. During seedling cultivation, producers employ different methods in field plots such as raised seed beds, sunken seed beds, or flat seed beds, adapting to soil type, production season, and crop types. Farmers typically utilize inorganic fertilizers, like urea, or compost for seedling nourishment, with varying application rates and frequencies. Concerning irrigation of seedlings, most farmers use watering cans, with the frequency and amount of watering varying depending on crop type, water availability, and micro-climate conditions of the area. In rare instances, some farmers opt for the flooding method to irrigate their seedlings, particularly when managing numerous seed beds of larger size.

*Figure 1:Seed bed with mulch around Meki area*

*Figure 2:Seedlings raised by farmers at Butajira area*

*Figure 3:Hot pepper seedlings raised in commercial farms @ Ethio-flora*

## 3.3 Field preparation

It is obvious to farmers that thorough land ploughing offers several advantages, including the incorporation of weeds and stubbles into the soil, clod breaking, controlling of soil moisture, aeration and temperature and levelling the field (Temesgen Mekuria et al., 2008). Considering these benefits, most vegetable producers opt to plough their lands 2-4 times, primarily based on soil type, crop types, and the chosen ploughing methods. In the assessment areas, vegetable producers employ either oxen ploughing or Tractor ploughing. Oxen ploughing, a low-cost and low-input method, is particularly favoured among smallholder farmers, utilizing a pair of oxen and a wooden plough. The choice between the two methods depends on factors such as soil type, crop type, terrain of the farm, and mainly the financial capacity of the producers.

## 3.4 Spacing and plant population

Plant population and suitable spacing are crucial management practices that significantly impact the yield and quality of crops. The spacing between plants and rows is determined by factors such as production methods, soil fertility, plant structure, and farm equipment to be used (Asfawu and Eshetu, 2015). Despite the development of appropriate plant and row spacing by research institutes in potential vegetable production areas, producers in these regions often varying spacing practices, even for the same crop and similar production purposes (**Error! Reference source not found.**4).

***Table 4. Producers' spacing practices compared to recommendations by Horti-LIFE project, Research institutes and companies for common vegetables.***

| Crop type | Recommendations from Horti-LIFE Spacing between | | Recommendations from Research Spacing between | | Applied by companies Spacing between | | Farmers practices Spacing between | |
|---|---|---|---|---|---|---|---|---|
| | Rows (m) | Plants (m) | Rows (m) | Plants (m) | Rows (m) | Plants (m) | Rows (m) | Plants (m) |
| Tomato | 1.00-1.20 | 0.40-0.60 | 0.30 | 1.00 | 0.60-1.00 | 0.40 | 0.50-1.00 | 0.4-0.8 |
| Onion | 0.40*0.20 | 0.05-0.07 | 0.40*0.20 | 0.05-0.07 | 0.20-0.30 | 0.08 | 0.30-0.40 | 0.04 |
| Hot pepper | 0.60-0.70 | 0.30-0.40 | 0.60-0.70 | 0.30-0.40 | 0.80 | 0.45 | 0.50-0.80 | 0.30-0.60 |
| Cabbage | 0.60 | 0.40 | 0.5-0.90 | 0.30-0.50 | 0.60 | 0.40 | 0.30-0.40 | 0.40 |

***Sources:*** *Production manuals from Horti LIFE, research institutes, companies and assessment results.*

## 3.5 Irrigation management

Ethiopia is noted for having abundant surface and groundwater resources. However, its agricultural sector has not incorporated water management and irrigation technologies (Belete Berhanu et al., 2013). Findings from the assessment indicate that in marketing areas of the companies, water for irrigation is sourced from rivers, lakes, springs, groundwater, and occasionally from water harvesting. In these production areas, farmers typically employ two types of irrigation methods: surface irrigation and pressurized irrigation. Some farmers utilize a combination of both methods. Pressurized irrigation involves using a motor pump to extract water from sources such as hand-dug wells, harvested water, or diversions.

Whatever sources of water are used, the furrow irrigation method is the most common practice used by farmers in Ethiopia in general and in the assessment areas in particular. Water management is often deficient due to a lack of experience and skills, leading to issues such as salt accumulation in areas where water sources exhibit salinity problems. This can result in soil compaction, increased disease occurrence, and water scarcity. Nevertheless, in certain regions of the CRV, commercial vegetable producers have adopted drip irrigation systems. These systems help to produce quality vegetables with efficient use of water.

Irrigation frequency (when applied) is an important parameter during irrigation for optimal water utilization. Producers located in proximity to irrigation schemes with modern canal systems, constructed by the government or development partners, typically adhere to scheduled irrigation practices, while others irrigate their lands whenever water becomes available. Irrigating lands in an unscheduled manner can adversely affect crop production and productivity. For instance, sensitive crops with shallow root systems require frequent irrigation, and failure to provide water on time can lead to a reduction in yield below their potential. A situation which is common for many vegetable producers.

## 3.6 Soil fertility management

Plants require an adequate amount of nutrients to achieve high yields of quality crops. The application of organic fertilizers to the soil immediately after harvest and during the initial ploughing helps maintain soil fertility, promotes soil health, and increases organic matter content. However, vegetable growers primarily rely on inorganic fertilizers such as Urea, NPS, and occasionally potassium chloride to supply potassium. The application of compost, vermicompost, or farmyard manure as organic fertilizers at the field level is relatively uncommon, except in cases where growers are cultivating vegetables in backyard settings.

In terms of rate, time and place of application for inorganic fertilizers, numerous studies have been carried out nationally by various research institutes. Notwithstanding these, vegetable growers are practicing the application of fertilizers at excess rates as compared to the research recommendations, which could lead to pollution of the environment from high rate of application and runoff into water bodies and leaching into the groundwater with economic loss. Application rates used by growers in comparable locations often differ from the recommendations provided by research institutes (**Error! Reference source not found.**).

For instance, in the central Rift Valley, vegetable growers are applying up to 1200 kg $ha^{-1}$ of urea and 1000 kg $ha^{-1}$ of NPS to produce tomatoes, while Melkassa Agricultural Research Centre has long recommendation of 100 kg $ha^{-1}$ of Urea and 200 kg $ha^{-1}$ of NPs for commonly cultivated vegetable crops including tomatoes (Table 5). This finding is consistent with the observations of Edossa et al. (2014), who reported that growers in similar areas apply 600 kg $ha^{-1}$ or more for tomatoes without adhering to recommended rates. Growers typically employ three split applications for urea; at transplanting, and during the first and second cultivations as top-dressing, while NPS is applied at transplanting only as side dressing.

***Table 5. Producers' fertiliser application practices compared to recommendations by Horti-LIFE project, Research institutes and companies.***

| Crop type | Recommendations from Horti-LIFE Rates (Kg $ha^{-1}$) | | | Recommendations from Research Rates (Kg $ha^{-1}$) | | | Applied by some companies Rates (Kg $ha^{-1}$) | | | Producers` practices Rates (Kg $ha^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Urea | NPS | KCL | Urea | NPS | KCL | Urea | NPS | KCL | Urea | NPS | KCL |
| Tomato | 645 | 400 | 900 | 100 | 200 | - | 530 | 600 | 900 | 1200 | 1000 | - |
| Onion | 350 | 160 | 375 | 100 | 200 | - | 150 | 200 | 123 | 600 | 400 | - |
| Hot pepper | 490 | 160 | 640 | 100 | 200 | - | 760 | 325 | 975 | 1200 | 800 | - |
| Cabbage | 330 | 200 | 100 | 125 | 250 | - | 350 | 200 | 100 | 600 | 400 | - |

***Sources:** Production manuals from Horti-LIFE, research institutes, companies and assessment results.*

## 3.7 Pest management

The yield and quality of vegetable crops are highly affected by many biotic factors among which disease and insect pests are the major problems. In general pest management refers to the use of various methods to prevent or control pest infestations, such as cultural practices, biological control, host-plant resistance, and chemical pesticide control (Bayeh Mulatu, 2024).

When we talk about pest management, the first term that springs to mind is Integrated Pest Management (IPM), which is an approach designed to manage pests and diseases with as little damage as possible to people and the environment. It focuses on long-term prevention or suppression of pest problems. Different strategies and practices are used within IPM, including scouting and monitoring, as well as preventive cultural, mechanical, and biological control in a compatible manner. Corrective chemical pesticide control measures are also used as a last resort.

However, in the assessment areas, most of the vegetable producers relied on the application of pesticides alone without considering other pest management options. They have little tolerance for pest infestations and lack knowledge about the health and environmental risks related to pesticide usage, as well as correct usage of pesticides. They generally apply pesticides in violation of the recommendations made by different research and knowledge institutes. These violations relate to the dose, frequency, methods, and timing of spraying, as well as the pre-harvest interval (PHI) of respective pesticides. Furthermore, farmers fail to adhere to risks and safety instructions, neglect to utilize appropriate personal protective equipment during pesticide applications, neglect the use of safe storage facilities, and inadequately dispose of pesticide containers.

Because they believe that larger doses plus the mixing of pesticides will result in better insect eradication, vegetable growers typically used higher dosages of pesticides than recommended, mixing up to two to four pesticides at once. If pests are not sufficiently controlled after the pesticide application, farmers tend to increase the dosage and the frequency of application. If they change the types of pesticides, it is without any adequate instruction, resulting in the use of fungicides when insecticides are needed and vice versa. The application of ineffective pesticide categories was also common. Some tomato farmers mix insecticides and fungicides and spray as many as 20 times through the growing period (**Error! Reference source not found.**).

The assessment results indicate that economically significant pests are late and early blights, powdery mildew, and bollworm that affect tomatoes and peppers, as well as the tomato leaf miner (*Tuta absoluta spp*.) in tomatoes. Thrips on onions, and aphids on cabbage, are prevalent across vegetable production areas and are key pests. These findings align with those reported by Gashawbeza and Ferdu (2019), who reported that bollworm and tomato leaf miners in tomatoes, thrips on onions with varying population pressures based on agroecology, and aphids on cabbage are common and economically important wherever those crops are cultivated all over the country.

In Ethiopia, the most common pesticide spraying equipment was the manual hand-pumped knapsack sprayer of 15, 20 or 25 litters (FAO, 2001). The use of a knapsack sprayer exposes the sprayer to health risks if not protected. Farmers in the assessment areas usually sprayed pesticides wearing only T-shirts, shorts and flip-flop sandals or bare feet that offer little or no protection (**Error! Reference source not found.**). The main reasons mentioned for not using personal protective equipment were lack of availability (not provided) and affordability (when available), lack of awareness about the health hazards of pesticides as their negative health effects are not immediate, while some producers considered it uncomfortable under hot and humid conditions.

*Figure 4:A farmer spraying pesticide without any PPE*

*Table 6. Important diseases and their controlling pesticides for tomatoes, onions, peppers and cabbage in the assessment areas*

| Crop type | Important disease pests in most production areas | Recommendations from Horti-LIFE | Pesticides used by producers | Remarks |
|---|---|---|---|---|
| Tomato | Late blight (*Phytophthora infestans*), Early blight *(Alternaria solani)* Damping off, Powdery mildew (*Pseudoidium neolycopersici)* | Mancozeb 80% WP, Mancozeb 64% + Metalaxyl 8% WP/WG and Copper Hydroxide or Copper oxychloride for blights. Kresoxim-methyl, Triadimefon, Trifloxystrobin+Tebuconazole and Copper Hydroxide or Copper oxychloride for Powdery mildew | Mancozeb+ metalaxyl-M, Redomil gold, Cerozeb, Agrolaxy, Kocide, Tricel 48% EC (Chlorpyrifos), Karate and Rova 75WP | Farmers use with PHI= 1 day, and they spray up to 20 times throughout the growing period |
| | Fusarium wilt, | | Bayelton, Tilt, Dimethoate and copper-based fungicides | |
| | Tomato yellow leaf curl virus (TYLCV), Tomato mosaic virus (ToMV), Tobacco mosaic virus (TMV) | | Champion 50 % WP, Mancozeb, Metalaxyl, Ridomil gold and Perfecto | Champion 50 % WP is imported only for the flower industry and is found on tomato farms |
| Onion | Root rot, purple blotch (*Alternaria porri),* Downy mildew | Metalayx 8%+mancozeb 64% and copper hydroxide for Downy mildew, purple blotch and Downy mildew | Metalayx 8%+mancozeb 64%, Ridomil gold, profit, Cerozeb, Bayelton, Karate, Tricel 48% EC (*Chlorpyrifos*) and Copper hydroxide | Farmers use with PHI=7 days |
| | Botrytis leaf blight (BLB) | | Mancozeb, Metalaxyl, Acrobat and Rovral | |
| Peppers | Fusarizm wilt | | Bilaton and Tilt, Kocide and Ridomil gold | |
| | Late blight, Early blight, Damping off, powdery mildew | Kresoxim-methyl 500g/L, Trifloxystrobin+Tebuconazole, Triadimefon 500g a.i./kg for Powdery mildew; | Mancozeb+metalaxyl-M, Redomil gold, Cerozeb, agrolaxy, kocide, Tricel 48% EC (*Chlorpyrifos*), Karate and Rovral | |
| Cabbage | Alternaria leaf spot | | Fungozeb, Ridomil gold and Mancozeb and copper-based fungicide | |
| | Downy mildew | | Kocide, Karate and Tricel 48% EC (Chlorpyrifos) | |
| | Black rot | Copper Hydroxide or Copper Oxichloride | Mancozeb+metalaxyl-M and Ridomil gold | |

Where, PHI= Pre-Harvest Interval

***Sources:*** *Production manuals from HortiLIFE, research institutes, companies and assessment results*

*Table 7. Important insect pests and their controlling pesticides for tomatoes, onions, peppers and cabbage in the assessment areas*

| Crop type | Important insect pests in most production areas | Recommendations from Horti-LIFE | Pesticides used by producers | Remarks |
|---|---|---|---|---|
| Tomato | Aphids | | Profit and Karate | |
| | White flies (*Bemisia tabaci, Trialeurodes vaporarorium*) | Azadirachtin 0.03%, Lambda-cyhalothrin 50g/L, Alpha-cymermethrin 100g/L, Thiamethoxam 250g/L, Thiocyclam SP 50% | Actara 25 WG (Thiamethoxam 250g/Kg), Confidor SL 200(Imidacloprid 200g/L), Cybolt 2.5ULV (Flucythrinate 2.5% ULV), Fastac 100g/L EC (Alphacypermethrin) and Dimethoate | PHI=10 -15 days |
| | Bollworm (*Helicoverpa armigera*) | Deltamethrin 25g/L, Alpha-cymermethrin 100g/L, Azadirachtin 0.03% | Agro-Lambacin Supper 315 EC, Dimethoate 40% EC (Agro-Thoate 40% EC), highway 50 EC (Lambda-cyhalothrin) | PHI=15 days |
| | Tomato leaf miner (*Tuta absoluta spp*.) and thrips | Flubendiamide 480g/L, Chlorantraniliprole 200g/L,Spinosad 480g/L, Spnetoram 250g/L for tomato leaf miner; | Coragen 200SC, Tracer 480SC, Ampligo 150ZC, Radiant 120 SC, Karate 5%EC, lamdex 5% EC and Lambda-cyhalothrin | PHI= 14days |
| | Red spider mites (*Tetranychus urticae*) | | Dynamec 1.8 EC, Secure 36% SC (Chlorfenapyr), Apollo, Nissorun (Hexythiiazox) coragen, karate and Dimethoate | |
| | Nematodes | | Diazinon and Karate | |
| Onion | cut worms | | Rodomil gold, profit 72%EC, Thiodan 50 WP, Karate and Radiant120 SC | PHI=20 days |
| | Onion Thirps (*Thrips tabaci*) | Lambda-cyhalothrin 50g/L, Spinetoram 250g/L, Trifloxystrobin+Tebuconazole | Nimbicidine (Neem), Tracer, Karate 5%EC, lamdex 5% EC and Lambda-cyhalothrin, Profit | |
| Peppers | Whiteflies | Alpha-cymermethrin 100g/L, Lambda-cyhalothrin 50g/L, Azadirachtin 0.03%, Thiamethoxam 250g/kg, Thiocyclam SP 50% | Karate and Profit | |
| | Bollworm | Deltamethrin 25g/L, Alpha-cymermethrin 100g/L, Azadirachtin 0.03% | Thionex 25% ULV, Endosulfan, Helerat5%EC | |
| | Aphids | Deltamethrin 25g/L, Alpha-cymermethrin 100g/L, Azadirachtin 0.03%, Lambda-cyhalothrin 50g/L, Imidachloprid 200 g/L | Dimethoate, Profit, Agrothoate and Closer 240 SC | PHI=14 days |

| | | | | |
|---|---|---|---|---|
| Cabbage | Cabbage aphids | Deltamethrin 25g/L, Alpha-cymermethrin 100g/L, Azadirachtin 0.03%, Lambda-cyhalothrin 50g/L | Diazinon, Karate, Dimethoate, Con-fidence | PHI=15 days |
| | Diamond black moth | Chlorantraniliprole 200g/L, Azadirachtin 0.03%, Alpha-cymermethrin 100g/L, Deltamethrin 25g/L, Spinetoram 230g/L, Spinosad 480g/L, Flubendiamide 480g/L | Endosulfan, Dimethoate, Deltamethrin, Karate, Tracer and Con-fidence | |
| | Flea beetles | | Cypermethrin, Deltamethrin and Tracer 480 SC(Spinosad) | |
| | Cut worms | | Karate, Dimethoate and Deltamethrin, | |

Where, PHI= Pre-Harvest Interval

*Sources: Production manuals from Horti-LIFE, research institutes, companies and assessment result*

## 3.8 Challenges the producers are facing

Vegetable producers in the assessment areas are facing the following challenges:

**Timely unavailability of inputs**: Improved seeds, fertilizers, and insecticides are frequently unavailable when needed, which has an impact on quality and productivity of vegetables.

**Limited knowledge and skill on improved production and post-harvest handling practices**: The lack of skills and knowledge in effective pest control techniques, proper fertilizer and irrigation management, proper post-harvest handling, and adequate market information has a substantial impact on vegetable production in the assessment areas.

**High cost of inputs like improved seeds, pesticides and fertilizers:** This has a significant impact on the production of vegetables in such a way that it reduces the adoption of improved technologies, increases the production costs which may leads the farmers to financial strain and potential debt and limits the market competitiveness due to experiencing of lower yields with poor quality.

**Limited availability of financial services:** Small-scale vegetable producers have limited access to financial services, making it difficult for them to invest in essential inputs such as high-quality seeds, fertilizers, pesticides, and irrigation systems, preventing them from adopting improved technologies and increasing productivity.

**Scarcity of available land as long as irrigated wheat is emerging as a competitor to vegetables:** The government is now pushing farmers to produce wheat with irrigation instead of high-value crops like vegetables, which none of them wanted to do, especially those within a 150-kilometer radius of Addis Ababa. Obviously, cultivating high-value crops is considerably more cost-effective than growing cereals like wheat in places close to potential markets with access to irrigation and infrastructure. Farmers in the aforementioned production areas regard land shortage to be a challenge.

**High incidence of pests:** The high incidence of pests remains a persistent problem, leading to substantial increase in production cost and pre-harvest losses. For instance, tomato producers are experiencing losses of up to 30% due to pests, diseases, and adverse weather conditions.

**Poor market linkage:** Many farmers are struggling to access larger, more profitable markets due to inadequate infrastructure and lack of market information in which they rely on middlemen to sell their produce. Results from the assessment indicate that, producers are losing up to 50% of their profit due to the interference of brokers.

# 4 Potential Sustainable Agricultural Practices that can be demonstrated and promoted to farmers

Based on the assessment result and the expertise from Wageningen Plant Research, a list of Sustainable Agricultural Practices (SAPs) appropriate for demonstration and promotion within the companies' marketing areas was developed.

**Pest management:** Pest management poses a significant challenge for farmers, as they struggle to control yield and quality losses caused by insect pests and diseases. Current management practices predominantly rely on a limited selection of accessible pesticides, with minimal utilization of alternative methods such as crop disease resistance or cultural practices. A notable lack of awareness, knowledge, and skills regarding pest management is evident among the majority of farmers. The assessment result highlights producers' inadequate understanding of best practices for product selection, field application, and the health hazards associated with pesticide use. It is recommended that companies consider awareness-raising, demonstration, and training programs related to:

- Pest and symptom identification.
- Judicious use of pesticides, which involves pesticide selection and application to address issues related to pesticide over-application at high frequencies and inappropriate types of pesticides for perceived target pests.
- Demonstration trials should be designed to assess a range of pesticide management strategies, showcasing the efficacy of adequate IPM solutions and the selection and application of pesticides for correctly identified pests. This involves using optimal doses and frequencies while considering the use of less-hazardous pesticides and staying below the economic threshold level for application.
- Additionally, it is advised to explore other locally efficient integrated pest management (IPM) practices, such as:
    - Pest-resistant crop varieties
    - Crop rotation
    - Pest trapping and monitoring
    - Intercropping
    - Soil solarization/bio-fumigation

**Soil Fertility Management**: When it comes to soil fertility management strategies, it is crucial to develop and promote technologies that sustain soil fertility and soil health. Priority should be given to avoiding excessive applications of inappropriate inorganic fertilizers by integrating other soil amendments and management practices, such as:

- Organic fertilizers like farmyard manure, compost (vermicompost), incorporation of crop residues.
- Cover crops / green manures.
- Intercropping with legumes to supply nitrogen to the soil.
- To assess available soil nutrients, the adoption of easy-to-use soil testing kits is advised.

- Furthermore, it is advisable and essential for widespread adoption to standardize the recommendations for the rate, timing, and application methods of inorganic fertilizers in similar areas, considering economic feasibility.

**Water management:** Inadequate water management causes water-stressed crops and contributes to soil problems and disease outbreaks in many production areas resulting in poor plant growth.

- Innovative irrigation management solutions can be demonstrated, such as saline water treatment.
- Introducing efficient irrigation techniques like drip irrigation.
- Mulching in combination with modifications to the commonly used furrow irrigation.
- Capacity building and awareness around irrigation management and water conservation is needed, including:
    - Simple soil water holding capacity tests.
    - Disease management to avoid dissemination of diseases through irrigation water.

**Post-harvest management and marketing:** Poor market linkages and fluctuating prices can cause vegetable growers to lose up to 50% of their potential profit, making market linkages one of their main challenges. To tackle this challenge, a systematic approach is required. One effective strategy could be to organize producers into groups to collectively offer vegetable produce that meet the requirements of potential customers such as supermarkets and processing factories. The breeding companies have a key role and interest in promoting the quality aspects of their varieties and could play an important role of facilitating connections among various producer groups and potential costumers demanding quality produce. Additionally, farmers need to be educated on the importance of production planning for the targeted commodities and post-harvest handling techniques which can improve the quality and shelf life of their produce.

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# Annex I: ESP – Sustainability in agriculture

**ESP – Sustainability in agriculture**
This document outlines the Ethiopia-Netherlands Seed Partnerships' definition of sustainability in agriculture and outlines examples of sustainable agricultural practices (SAP).

**Definition of sustainability and its dimensions:**
ESP defines sustainability in agricultural systems as production practices that meet the needs of the present and future by minimizing or eliminating negative impacts on the environment and society. It involves the development and implementation of agricultural innovations that are economically viable, environmentally friendly and socially responsible.

Sustainable agriculture aims to maintain and improve soil health, conserve water resources, protect biodiversity, and minimize leaching and emissions of synthetic plant nutrients and greenhouse gases while strengthening resilience to climate change and enhancing the livelihoods of farmers and rural communities. This can be achieved through a variety of sustainable agricultural practices that respond to three defined dimensions of sustainability in agriculture:

1. Economic sustainability: Focus on ensuring that agriculture is economically viable and contributes to the livelihoods of farmers and rural communities. This includes practices such as improving efficiency and productivity, diversifying income sources, and promoting fair trade.
2. Environmental sustainability: Focus on minimizing the negative impact of agriculture on the environment and improving adaption to a changing environment with weather extremes. This includes climate-smart agricultural practices and practices that reduce emissions, conserve soil and water resources, and protect biodiversity.
3. Social sustainability: Focus on ensuring that agriculture contributes to social well-being and equity. This includes practices such as ensuring food security and access to nutritious food, promoting gender equality and social inclusion, and protecting the well-being of farm workers.

**Sustainable agricultural practices (examples):**

**Crop rotation:** involves planting different crops in a sequence to help manage pests and diseases, improve soil health, and reduce the need for synthetic fertilizers and pesticides.

**Intercropping:** involves growing two or more crops together in the same field. For example, planting potato with beans or basil can help to deter pests and improve soil health.

**Cover crops:** help to suppress weeds, improve soil health, and reduce erosion. Legume cover crops can also fix nitrogen in the soil. Can be partially harvested or incorporated in the soil.

**Organic fertiliser:** involves the use of animal manure or composted organic waste to supplement other fertiliser sources.

**Improved water management** involves improved irrigation techniques compared to conventional furrow irrigation. It may involve drip irrigation or micro-sprinkler irrigation and solar-powered energy-saving pumping mechanisms.

Improved fertiliser management; fertiliser plan based on crop nutrient requirements (e.g. recent soil analysis, productivity, crop cycle): involves improved fertilisation techniques compared to the conventional broadband application of conventional synthetic fertiliser and application of the 4R principles (one to four of the four principles; more principles = more sustainable):

- Right source (recommendations from Horti-LIFE, research centers, companies, other?)
- Right rate (soil lab analysis, productivity)
- Right time (crop cycle)
- Right place (improvement of broadcast application: band/row placement, by plant, soil incorporation by seed, according to water movement)

https://nutrientstewardship.org/4rs/4r-principles/

**Cultural weed management** involves the cultural management of weeds instead of the use of synthetic herbicides. Principally the use of mechanical and manual weeding.

**Mulching:** involves covering the soil around plants with a layer of organic (straw) or inorganic material (plastic). It can provide several benefits, such as weed suppression; moisture conservation, which is important in hot and dry climates; soil temperature regulation; and pest and disease control.

Integrated pest management (IPM) when applying plant protection products, whereby chemical agents are used more efficiently and their use is reduced: includes pest monitoring and warning techniques, agricultural practices to improve crop resilience including host resistance, biological control, and well-considered use of chemical control. IPM includes optimal pesticide selection and application; right product, right time, right dose and right place, while using the right personal protective equipment and optimising the application equipment.

Biodiversity conservation: involves ecological infrastructure to conserve natural pest enemies and pollinators, such as flower strips, hedges and other areas with service crops of non-sellable plantings.

# Annex II: Checklist for the assessment

**1. Description of the study area:**

- Region:_______________________________________________
- Zone: ______________________________________________________
- Name of district: ____________________________________________
- Number of *kebele*s suitable for vegetable production: ____________________________
- Access to the main road: Excellent________Good _________ Poor___________
- Type of producers:
    - ✓ Local farmers:______________________________
    - ✓ Producing by land leasing: ______________________
- What are the major Soil types?________________________________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  ________________________
- Type of production system:
    - ✓ Rain fed:______________________________________
    - ✓ Irrigated: ______________________________________
- The opportunities of the area to produce vegetable crops:______________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

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  ____________________________________________________________________________________

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  _________________
- The challenges of the area to produce vegetable crops:_________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  ____________________________________________________________________________________

  _________________________

❖ **Vegetable Crops production management**

✍ **Crop production system**

**Rain fed ___________________% (Belg ____________% Meher _________________%)**

**Irrigated _______%**

| **Cropping system** | **Type of Crops cultivated** | **Remark** |
|---|---|---|
| Rain fed | | |
| Irrigation | | |

| **Methods of irrigation** | **Estimated area covered** | **Remarks** |
|---|---|---|
| ✓ Furrow irrigation (using modern canal) | | |
| ✓ Furrow irrigation (using traditional canal) | | |
| ✓ Drip irrigation | | |
| ✓ Other (if any) | | |

➢ Source of irrigation water (river diversion, pond, lake, shallow borehole, deep boreholes…) ______________________________________________________________________________________________________________________________________________________

✍ **Land preparation practices**

| **Crop types** | **Tillage** | | **Cultivation** | | **Cropping system (explain common practice for the crop/rotation, intercropping or else)** |
|---|---|---|---|---|---|
| | **Frequency** | **Methods (Oxen, tractor, hand)** | **Type** | **Frequency** | |
| | | | | | |

Are there any problematic soil amendment practices (for Acidic or Sodic Soils)? _______________________________________

If yes, what are they?__________________________________________________________________________________________________

✍ **Use of seed and/or Seedlings**

| **Crop types** | **Type of planting (%)** | | **If seedlings are the sources, their proportion (%)** | | **If own method of raising is there, their proportion (%)** | | **If purchased, where is the source (from other farmer/professional company) and price?** |
|---|---|---|---|---|---|---|---|
| | **Seed** | **Seedling** | **Own** | **Purchased** | **Bed (raised or flat)** | **Seedling trays** | |
| | | | | | | | |

✍ **The common practices for raising of seedlings by farmers them selves**

| Crop types | Seed rate for one hectare | Seed bed (raised/flat) With or mulching | Seedling management | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Watering | | Fertilizer | | | | Pesticides (if any) | |
| | | | | | Inorganic | | Organic | | | |
| | | | Method | Frequency | Type | Rate | Type | Rate | type | Rate |
| | | | | | | | | | | |

- **Crop Management practices**

| Crop types | Spacing (m) | | In organic fertilizer (qt/ha) | | | | Organic fertilizer | | Bio-fertilizer | | Irrigation | | Trellis (if any) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B/n plant | B/n rows | Urea | NPS | KCl | Other (if any) | Type | Rate (ton/ha) | Type | Rate | Methods | Interval | |
| | | | | | | | | | | | | | |

- **Pest management practices**

| Crop type | Common pest (Diseases) | pesticides usage | | | Last spray before harvest (# of days) | IPM practices |
|---|---|---|---|---|---|---|
| | | Type (commercial name) | Rate | Frequency | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

- **Pest management practices…cont.**

| Crop type | Common pest (insects) | Insecticidal usage | | | Last spray before harvest (# of days) | IPM practices (insect traps or netting) |
|---|---|---|---|---|---|---|
| | | Type (commercial name) | Rate | Frequency | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

- **Pest management practices…cont.**

| Crop type | Common pest (Weeds) | Herbicidal usage | | | Hand weeding | |
|---|---|---|---|---|---|---|
| | | Type (commercial name) | Rate | Frequency | Time | Frequency |
| | | | | | | |
| | | | | | | |
| | | | | | | |

- For pesticide usage, how do you perceive the appropriate utilization of personal protection equipment (PPE)?____________________________

- **Marketing, post-harvest handling practices and related issues**

| Crop types | Storage | | Marketing | | | | Estimated loss (%) during | | |
|---|---|---|---|---|---|---|---|---|---|
| | Methods | Duration | Pre-arranged market | At farm gate | Local market | Transport to cities | Harvesting | Storage | Transporting |
| | | | | | | | | | |

- Are there any post-harvest handling techniques:____________________________

General remarks (if there are any observation from the enumerator/s or any practices that did not included here)- ____________________________

Ethiopian Seed Partnership (ESP)
www.esp-seed.org

Stichting Wageningen Research Ethiopia
www.wur.eu

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