

Organizing Principles for Agroecological Kitchen Gardens in Mandla, Central India

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A user manual for farmers and extension workers



Organizing Principles for Agroecological Kitchen Gardens in Mandla, Central India

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Introduction

Homestead kitchen gardens are critical for enhancing food and nutritional security, ecological resilience, and livelihoods in rain-fed and forest-dependent landscapes. Homestead gardens are generally small plots adjacent to households that provide families with regular supplies of vegetables, fruits, tubers, leafy vegetables and medicinal plants, forming a critical foundation for daily nutrition, food security and overall health. The Agroecological Homestead Model (AHM), developed under the CGIAR Agroecology initiative, incorporate agroecology principles by integrating multilayer cropping, composting, water harvesting, livestock and pollinators to enhance homestead gardens' resilience to climate and livelihood stressors, improve dietary diversity, and increase the diversity of the agroecosystem. Both kitchen gardens and AHM are being implemented and studied in Mandla, demonstrating that multilayer, mixed-crop homestead gardens can substantially increase production and dietary diversity while reducing dependence on external inputs and climatic vulnerability ([Kumar et al., 2024](#); [Singh et al., 2025](#)). However, while these outcomes are evident, the ecological mechanisms through which diversity in kitchen-gardens translate into stability, productivity and resilience are understudied and poorly understood.

Agroecological kitchen gardens function as spatio-temporal niche systems, in which crops are assembled to minimize competition while maximizing beneficial interactions and ecosystem services across seasons. This framework allows kitchen gardens to be organized not merely as collections of random crops, but as dynamic agroecosystems whose stability and productivity emerge from the timing of planting and harvesting, functional traits and interactions among crop species. Here, we outline the key considerations that integrate functional traits of crops, interspecific competition as well as cooperation and ecosystem services as interacting drivers that should be considered while designing a kitchen garden. Further, we provide a crop calendar that can be used by farmers and extension workers to choose the crop combinations based on local requirements.

Rationale

In Mandla district of Madhya Pradesh, India, where forests and farming are deeply intertwined, the kitchen gardens occupy a far more important role than is usually recognized in agricultural planning. Mandla is in a hot sub-humid zone and agriculture is dominantly rain-fed, with nearly 88 per cent of its cultivated area dependent on monsoon rainfall ([Malaiappan et al. 2024](#)). The district receives annual rainfall of about 1,300 millimeters, most of which is received in just three to four monsoon months. Soil is generally degraded and nutrient-poor. Rainfall has become increasingly erratic, dry spells are increasing, and summer heat stress is rising in recent decades ([Sushant, 2013](#)). More than 80 per cent of farmers in the area are small, marginal or landless, and rain-fed agriculture rarely provides nutritious food for the whole year ([Malaiappan et al. 2024](#)). Black cotton soils, when present, are fertile but prone to cracking, waterlogging and nutrient imbalance. Water availability for farming varies greatly between seasons and locations, and scarcity is severe during summer. Although forests cover more than half the district, and are an important source of fruits, tubers, leaves and other foods, these resources are under pressure and access is often restricted.

With very few job opportunities, poor crop yields and restricted access to traditional forest products, the community is increasingly dependent on the government's public distribution system (PDS) of food grains at subsidized prices. Consequently, local diets have become dominated by rice and wheat (primary cereals provided by the PDS), while traditional foods dominated by millets, pulses, vegetables and wild foods have declined. Under these conditions, a well-managed kitchen garden offers one of the most reliable ways to ensure year-round access to diverse, nutritious food to the communities.

Traditionally, kitchen gardens, locally known as the *bari* or homestead in Mandla have been used to produce vegetables, tubers, greens, fruits, medicinal plants, and often integrate poultry and

other livestock. However, as farmers increasingly prioritize a few market-oriented, chemically intensive crops, their limited land, labor, and capital are diverted away from diverse homestead systems, leading to their decline in many villages. Changes in production have also led to dietary changes towards a lower dietary diversity, consequently leading to micronutrient deficiencies and local crop diversity loss (Mondal et al., 2021). Previous research in Mandla shows that creation of value chains for kitchen gardens has created new income streams improving smallholder farmer livelihoods (Sushant 2013).

Recent agroecological interventions in Mandla, particularly the AHM developed under the CGIAR Agroecology Initiative, demonstrate that reviving and redesigning kitchen gardens can have transformative impacts on nutrition, livelihoods and ecological sustainability (Singh et al., 2025). Where this model has been piloted, production and crop diversity have increased several-fold, consumption of leafy vegetables and nutrient-rich foods has risen sharply, and households have gained greater sovereignty over their food and, in many cases, provided families with additional incomes.

Unlike field agriculture, which is constrained by land size, rainfall, and market forces, the kitchen garden can be highly diversified and intensively managed and adapted to household needs. It is also typically managed by women, making it a suitable intervention for improving family nutrition and women’s agency. To realize its full potential, kitchen gardens must be designed as agroecological systems in which different plants, animals, soil organisms and water flows interact to support productivity, stability and resilience. Below, we discuss the key organizing principles (Figure 1) for effective utilization of Agroecological Kitchen Gardens in Mandla.

Organizing principles

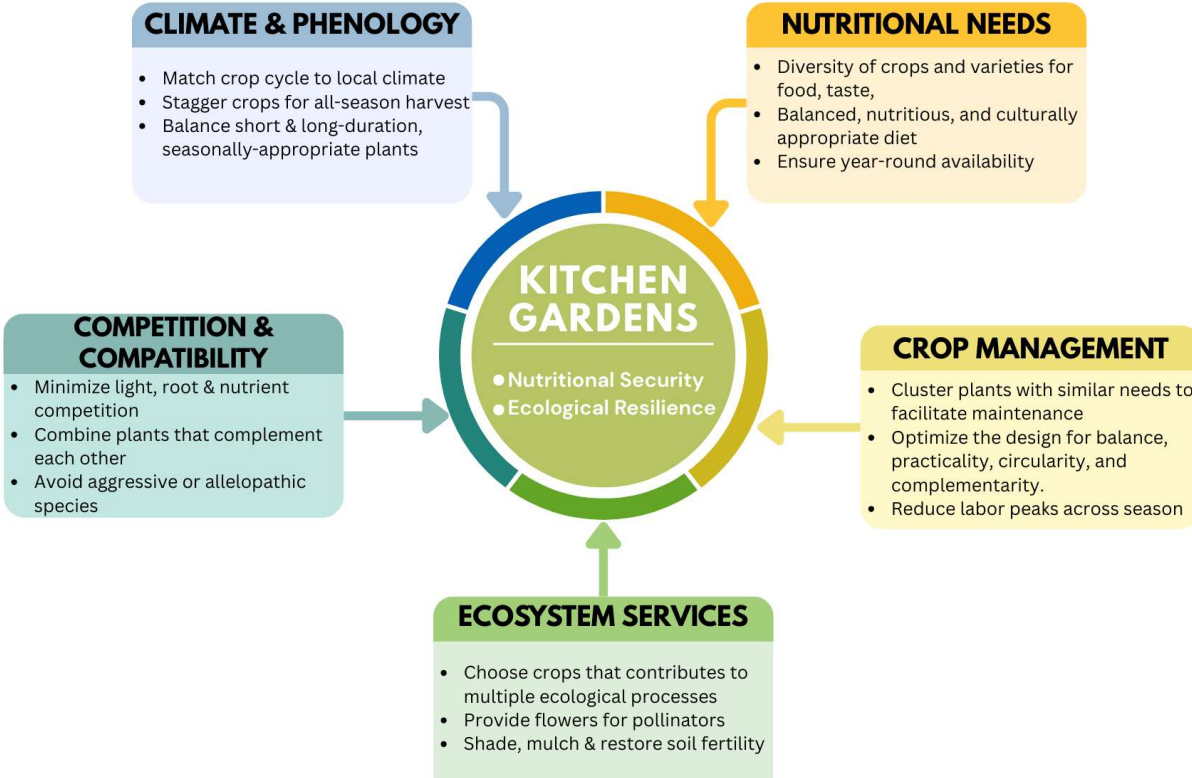


Figure 1: Organizing principles for planning a kitchen garden

1. Climate and Crop/varieties Phenology

The crop phenological events such as germination, flowering, fruiting and senescence have to be carefully planned based on the local weather and water availability. In Mandla, where nearly 90% of rainfall is concentrated between June and September and dry-season water stress is severe, phenology is a dominant ecological constraint. Crop failure often occurs not because rainfall is insufficient in total, but because crop water demands peaks during dry spells or heat waves.

Given increasing climate variability, the timing of planting has become as important as the choice of crops. In Mandla, the onset and breaks of the monsoon now vary widely from year to year, making fixed sowing calendars unreliable. Planting must therefore be adjusted to each season's rainfall pattern, soil moisture and temperature rather than following rigid dates. Early or late sowing can shift the entire phenological schedule of crops, determining whether flowering and fruiting coincide with favorable moisture and temperature conditions or with drought and heat stress. In agroecological kitchen gardens, flexible and responsive planting allows farmers to align crop phenology with actual weather conditions, reducing the risk of crop failure and ensuring more stable harvests under erratic and unpredictable climates.

In agroecological kitchen gardens, phenological diversity creates temporal complementarity. Fast-growing leafy vegetables such as amaranth and spinach reach harvest within weeks, ensuring regular availability, while shrubs such as brinjal and chilly consistently produce over several months, and tubers such as yams, turmeric and ginger mature over 3-4 months. When these are grown together, the garden's demand for water, nutrients and labor is distributed across time rather than concentrated in a single peak. The varying crop maturation times further reduces vulnerability to climatic shocks, ensuring a continuous food supply. Agroecological systems with high phenological overlaps (e.g., all crops peaking in water demand in December) are expected to show stronger competition, higher stress and greater failure rates than systems with staggered phenology, especially in areas susceptible to climate extremes and with limited water and nutrient resources.

Staggered phenology also supports ecosystem services, especially pollination. When different crops flower at different times, nectar and pollen are available to bees, flies and other pollinators throughout the year rather than in a short seasonal pulse. This sustains local pollinator populations and improves fruit set and yields of vegetables and fruit trees.

2. Competition and Compatibility

A central principle of agroecological kitchen gardening is the use of mixed and multilayered crop combinations. Instead of growing one crop in one bed, different types of plants are grown together in vertical and horizontal layers. Root and tuber crops such as turmeric, ginger and colocasia occupy the underground layer, storing nutrients and loosening the soil. Leafy vegetables such as amaranth, spinach and fenugreek form a low canopy that provides quick harvests and ground cover, which in turn is critical for retaining soil moisture. Shrubby vegetables such as brinjal, tomato, chilly and okra create a middle layer that yield continuously over several months. Climbers such as cowpea, gourds, cucumbers and beans grow upwards on bamboo trellises or tree crops, producing diverse food without taking up much ground space. Fruit trees such as papaya or moringa are added as a higher layer mostly on the edges.

Growing crops with complementary traits together enhances ecosystem functioning with multiple benefits ([Garnier and Navas, 2012](#)). By understanding the functional role of specific traits and trait-combinations, farmers can leverage plant genetic diversity to improve production outcomes. For example, crops differ in nutrient acquisition strategies and combining crops in-field based on these traits can improve nutrient uptake efficiency ([Joshi and Maiti, 2024](#)). Legumes such as cowpea and beans fix atmospheric nitrogen, reducing competition for soil nitrogen and facilitating neighboring non-legumes. Crops with high potassium demand (e.g., gourds) and those with high nitrogen demand (e.g., leafy greens) can coexist if organic nutrient sources are adequately supplied. Some plants support each other through biological interactions. Strong-smelling or pungent plants such as chilly, basil and marigold can repel certain insects. Diverse plantings also reduce pest incidences and slow the spread of diseases. On the other hand, planting large areas of closely related crops, such as multiple solanaceous vegetables, can lead to rapid pest build-up. A mixed planting pattern is therefore more resilient

and more strategic to use, recycle, and improve the limited resources (land, water, soil, nutrients).

Nutrient management is especially important in Mandla, where soils often have low organic matter and imbalanced fertility. Kitchen gardens should be designed around recycling nutrients rather than importing chemical fertilizers. Compost pits, vermicompost, farmyard manure, cow-dung based preparations and crop residues form the backbone of soil fertility in agroecological homesteads. Nutrient-heavy crops such as tomato, chilly and gourds should be placed closer to compost sources, while low-nutrient demanding crops such as leafy greens can occupy outer beds. Over time, this builds a living, biologically active soil that supports healthy plant growth.

Competition for light, nutrients, water and space is inevitable in such densely planted kitchen gardens. However, competition becomes destabilizing only when crops overlap strongly in their functional niches. In the homestead gardens like multilayer systems, crops differ strongly in height, rooting depth, canopy structure and nutrient demand. Tuber crops exploit deeper soil layers, leafy greens occupy the surface layer, shrubs form a mid-canopy, and climbers use vertical trellises. This creates spatial niche partitioning, reducing direct competition.

The competition for resources among crop plants in kitchen gardens should be evaluated not simply as crowding, but as trait-based overlap. High overlap in rooting depth, nutrient demand and phenological timing can lead to negative interactions, whereas complementary trait combinations may lead to neutral coexistence or even complementarity.

This kind of multilayer-mixed cropping system is particularly suited to kitchen gardens as it maximizes the use of small areas of land, suppresses non-crops, conserves soil moisture and creates a stable microclimate. Shade from climbers and taller plants protects the soil from intense sun and heavy rain, while continuous ground cover reduces erosion and evaporation. By spreading production across many species and layers, the system also reduces the risk that a single pest, disease or weather event will wipe out all the crops simultaneously from the garden. Multilayer-mixed cropping systems reduce competition by combining plants with different growth forms and rooting patterns. Deep-rooted crops draw water and nutrients from lower soil layers, while shallow-rooted leafy vegetables use the surface soil. Climbers use vertical space that would otherwise be empty. Problems arise when too many plants with similar needs or from the same taxonomic family are crowded together, such as when tomato and brinjal, both Solanaceae, are planted densely, since both demand high nutrients and attract similar pests. Mixing these with legumes, greens and climbers helps balance resource use and reduce stress on the soil.

3. Ecosystem services and disservices

Beyond food production, well-planned kitchen gardens provide a range of ecosystem services. Flowering plants and bee boxes support pollinators that improve yields in both gardens and nearby fields. Mixed vegetation and organic matter improve soil structure and water infiltration, reducing runoff and erosion. Shade, mulch and ground cover conserve moisture and moderate temperature extremes and improve soil biodiversity. Continuous plant growth captures carbon and builds soil organic matter. Staggered flowering times of different crops ensures continuous availability of nectar and pollen for pollinators and parasitoids. Ground cover and multilayer canopies reduce soil temperature and evaporation, improving water use efficiency. Legume–non-legume mixtures sustain soil nitrogen, while continuous organic matter inputs from multiple crops enhance microbial activity and nutrient cycling. These gardens can also include plants that contribute to health (e.g. medicinal) and to cultural values (e.g. traditional festivities), extending contributions beyond the biophysical processes. Together, these services make the kitchen gardens more resilient to droughts, heavy rain and heat waves. Crucially, these ecosystem services feed back into plant performance by reducing stress and increasing resource availability. This creates a positive feedback loop in which diversity stabilizes ecosystem processes, which in turn stabilizes crop yields.

However, poorly planned gardens can also generate ecosystem dis-services. Excessively dense trellises can trap humidity and promote fungal diseases during the monsoon. Overshading can reduce vegetable yields. Over-reliance on a few crops can increase pest pressure. Agroecological design therefore should aim for balance, often covering only part of the garden with climbers and ensuring good air flow and sunlight penetration.

4. Crop management

Management requirements also influence crop choice and layout. Some crops need frequent watering, weeding or pest control, while others are relatively low maintenance. Crops differ greatly in how much watering, weeding, staking and pest control they require. Vegetables such as tomato, chilly and leafy greens need frequent attention, while crops like turmeric, cowpea, moringa or sweet potato are comparatively low maintenance once established. Grouping high-maintenance crops together reduces labor and makes care more efficient. A good design should reduce unnecessary work while still providing diverse harvests. Rainwater harvesting along with greywater recycling provides a valuable source for irrigation in water-scarce farms. Planting high water demand crops near these water flows allows productive use of greywater while keeping low demand crops further away. Weed management is also a key part of agroecological design. Many plants often considered as weeds on monoculture farming, such as *bathua* (*Chenopodium*), purslane (*Portulaca* sp.), amaranth, and many leafy vegetables are edible, nutritious and traditionally used by the indigenous communities in Mandla. Instead of eliminating all non-crop plants, kitchen gardens can be managed to retain useful and underutilized edible species, allowing them to grow alongside cultivated crops. This approach reduces labor for weeding, protects soil from exposure, and increases the diversity of foods available to households, especially during lean periods.

5. Household food and nutrition needs

At its core, the kitchen garden must be designed to nourish the household members before it is expected to generate any surplus to be sold in the markets. This means planning crop combinations that together provide a balanced, year-round diet rather than focusing on a few high-value vegetables. Daily leafy greens such as amaranth, spinach, fenugreek and moringa supply essential micronutrients and should be continuously available. Pulses and legumes such as cowpea, beans and pigeon pea are rich in plant protein and also enrich soil fertility through nitrogen fixation. A diversity of vegetables and fruits ranging from gourds and tomatoes to papaya, banana and citrus ensures a steady supply of vitamins, minerals and dietary fiber. Spices and locally important medicinal plants such as turmeric, ginger, chilly, coriander, basil and *tulsi* not only improve the flavor and cultural acceptability of meals but also contribute to health and immunity. By aligning crop choices with household dietary needs, the kitchen garden becomes a reliable foundation for nutritional security, tasty foods, reducing dependence on markets and helping families meet their food requirements even during lean seasons.

Crop calendar for kitchen gardens in Mandla

The homestead model and kitchen gardens developed in Mandla provides a practical template for putting these principles into action. A typical model uses about 350 to 450 square meters of land, divided into eight to fifteen raised beds about one meter wide. Bamboo trellises, or trees, support climbing vegetables, while a small water harvesting structure or storage tank, known as a *Jal Kund*, provides irrigation during dry periods. Compost pits recycle organic waste, and many homesteads also include a poultry shed. Together, these elements create an integrated system in which nutrients, water and energy circulate within the homestead.

Within this space, farmers can plant a seasonal mix of vegetables that include tubers, herbs/ground cover (leafy greens), shrubs and climbers. During the monsoon, turmeric, taro, amaranth, brinjal, chilly, okra, cowpea and gourds dominate. In winter and summer, ginger, fenugreek, coriander, tomato, cucumber and beans take over. This seasonal rotation maintains soil health, disrupts pest cycles and ensures year-round availability of vegetables and spices. **Appendix 1** provides a crop calendar that can be used by farmers and extension workers to choose the crops for kitchen gardens. It is worth noting that Even within the same crop species, different varieties can differ greatly in their water needs, heat tolerance, pest resistance, and maturity periods; therefore, successful garden design depends not only on choosing the right crop, but also on selecting the right variety for local conditions and seasonal windows.

In agroecological zones such as Mandla, where summers are extremely hot and irrigation water is often scarce, maintaining kitchen gardens becomes difficult for a few months. During these lean seasons, plants that grow in and around farms and nearby forests such as wild edible plants, including tubers, form an essential source of nutrition. These locally adapted species are often highly nutritious,

resilient to heat and drought, and require no external input. For indigenous and forest-dependent communities, they provide critical dietary diversity and micronutrients during the summer months. Alongside wild edibles, perennial fruit trees in the kitchen gardens play a crucial role in sustaining household nutrition. Hardy species such as *bael*, *jamun*, *mahua*, *tendu* and *amla* are well adapted to these harsh conditions and edible, and fruits mature during the lean periods. They provide fresh fruits rich in vitamins, minerals, sugars and antioxidants at a time when other foods are limited. Tree species can be planted in the gardens but also throughout the field as companions to main crops (when compatible), and as live fences or wind breaks.

Food preservation practices followed by indigenous communities further strengthen this seasonal buffer. In Mandla, communities traditionally sun-dry vegetables such as tomatoes and bottle gourd and leafy vegetables such as *bathua* (*Chenopodium*), fruits like bael and amla are sliced and dried, mahua flowers are dried whole, and vegetables like gourds are processed with protein-rich pulses into products such as *badi*. This allows surplus harvests from the monsoon and winter seasons to be stored for later use. These preserved foods bridge the summer lean period, reduce post-harvest losses, and ensure a more continuous and resilient food supply throughout the year. Thus, carefully planned kitchen gardens along with wild edible plants and indigenous preservation methods forms a vital nutritional safety net and landscapes like Mandla.

Conclusions

A carefully designed and well-maintained kitchen garden is not marginal or secondary to main agriculture. They are powerful mechanisms to address malnutrition, climate vulnerability and livelihood insecurity in tribal and rainfed regions. Future work should prioritize the systematic documentation of non-crop food species, their phenology and nutritional profiles, and their integration into kitchen-garden and AHM designs. Doing so will allow agroecological homesteads and kitchen gardens to be explicitly designed not just for overall diversity, but to fill seasonal nutritional gaps, ensuring that households remain nutritionally secure even during the most vulnerable months of the year.

By turning every kitchen garden into a small, diverse and well-managed agroecosystem, communities can reduce their dependence on external inputs, markets and forests, while strengthening their own food sovereignty. In a landscape facing increasing climatic uncertainty and ecological stress, kitchen gardens offer a pathway to resilience that is rooted in indigenous knowledge and ecological principles. Therefore, kitchen gardens should be managed as ecological communities rather than simple farm plots. By explicitly linking phenology, competition, ecosystem services, and nutritional needs of the family, agroecological design turns small homesteads into highly efficient, resilient and multifunctional systems. A carefully planned homestead kitchen garden in Mandla can provide a basis for their refinement, monitoring and scaling across similar rain-fed landscapes in central India.

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Appendix 1: Crop calendar suggested for Mandla district of Madhya Pradesh, India. “1” indicates months with suitable growing conditions for the crop, while “0” indicates sub-optimal or unsuitable months for cultivation.

CROP CALENDER												
CROPS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
VEGETABLES												
Ash gourd (Petha)	1	1	1	0	0	1	1	1	1	1	1	1
Bean/Dolios	1	1	1	0	0	1	1	1	1	1	1	1
Bitter gourd (Karela)	1	1	1	0	0	0	0	0	0	1	1	1
Bottle gourd (Lauki/Turai/Ghiya)	1	1	1	0	0	0	0	0	0	1	1	1
Brinjal (Baingan)	1	1	1	0	0	0	0	0	0	1	1	1
Cabbage (Pattha Gobi)	1	1	1	0	0	0	0	0	0	1	1	1
Cauliflower (Gobi)	1	1	1	0	0	0	0	0	0	1	1	1
Chilli (Mirch)	1	1	1	0	0	0	0	0	0	1	1	1
Cucumber (Kheera)	1	1	1	0	0	0	0	0	0	1	1	1
Field pumpkin	1	1	1	0	0	0	0	0	0	1	1	1
French Beans	1	1	1	0	0	0	0	0	0	1	1	1
Green Peas (Matar)	1	1	1	0	0	1	1	1	1	1	1	1
Okra (Bhindi)	1	1	1	0	0	1	1	1	1	1	1	1
Pointed gourd (Parval)	1	1	1	0	0	0	0	0	0	1	1	1
Ridge gourd (Turai)	1	1	1	0	0	0	0	0	0	1	1	1
Snake gourd (Parval)	1	1	1	0	0	0	0	0	0	1	1	1
Spiny gourd (Kantola / Kakrol)	1	1	1	0	0	0	0	0	0	1	1	1
Sponge gourd (Torai)	1	1	1	0	0	1	1	1	1	1	1	1
Tomato (Tamatar)	1	1	1	0	0	1	1	1	1	1	1	1
FRUITS AND OTHER TREES												
Bael	1	1	1	1	1	1	1	1	1	1	1	1
Banana (Kela)	1	1	1	1	1	1	1	1	1	1	1	1
Coconut (Nariyal)	1	1	1	1	1	1	1	1	1	1	1	1
Custard apple (Seetaphal)	1	1	1	1	1	1	1	1	1	1	1	1
Drumstick	1	1	1	1	1	1	1	1	1	1	1	1
Guava (Amrud)	1	1	1	1	1	1	1	1	1	1	1	1
Jackfruit (Kathal)	1	1	1	1	1	1	1	1	1	1	1	1
Lemon (Nimbu)	1	1	1	1	1	1	1	1	1	1	1	1
Mahua	1	1	1	1	1	1	1	1	1	1	1	1
Mango (Aam)	1	1	1	1	1	1	1	1	1	1	1	1
Papaya (Papita)	1	1	1	1	1	1	1	1	1	1	1	1
Tamarind (Imli)	1	1	1	1	1	1	1	1	1	1	1	1
Ziziphus (Ber)	1	1	1	1	1	1	1	1	1	1	1	1
LEAFY VEGETABLES												
Chenopodium (Bathua/Chauli)	1	1	1	0	0	0	0	0	0	1	1	1
Coriander (Dhaniya)	1	1	1	0	0	1	1	1	1	1	1	1
Green amaranth (Chaulai)	1	1	1	0	0	1	1	1	1	1	1	1
Methi (Fenugreek)	1	1	1	0	0	0	0	0	0	1	1	1
Red amaranth (Laal Bhaji/Saag)	1	1	1	0	0	1	1	1	1	1	1	1
Spinach (Palak)	1	1	1	0	0	0	0	0	0	1	1	1

CROP CALENDER												
CROPS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TUBERS												
Cassava	1	1	1	0	0	1	1	1	1	1	1	1
Colocasia (Arbi)	1	1	1	0	0	1	1	1	1	1	1	1
Ipomea (Sweet potato)	1	1	1	0	0	1	1	1	1	1	1	1
Onion (Pyaz)	1	1	1	0	0	0	0	0	0	1	1	1
Potato (Aloo)	1	1	1	0	0	1	1	1	1	1	1	1
Radish (Mooli)	1	1	1	0	0	0	0	0	0	1	1	1
Turmeric (Haldi)	1	1	1	0	0	1	1	1	1	1	1	1
Yam (Sooran)	1	1	1	0	0	1	1	1	1	1	1	1
CEREALS												
Kodo millet (Kodo)	1	1	1	0	0	0	0	0	0	1	1	1
Kutki millet (Kutki)	1	1	1	0	0	1	1	1	1	1	1	1
Maize (Makka)	1	1	1	0	0	1	1	1	1	1	1	1
Rice (Dhan)	1	1	1	0	0	1	1	1	1	1	1	1
Wheat (Gehu)	0	0	0	0	0	1	1	1	1	1	0	0
PULSES												
Bengal Gram/ Chikpea (Chana)	1	1	1	0	0	1	1	1	1	1	1	1
Lentil (Masoor)	1	1	1	0	0	0	0	0	0	1	1	1
Pigeon pea (Tur/Arhar)	1	1	1	0	0	1	1	1	1	1	1	1
Black gram (Urad)	1	1	1	0	0	0	0	0	0	1	1	1
OILSEEDS												
Flaxseed (Alsi)	1	1	1	0	0	0	0	0	0	1	1	1
Mustard (Sarson)	1	1	1	0	0	0	0	0	0	1	1	1
Niger seed (Ramtil)	1	1	1	0	0	0	0	0	0	1	1	1
Rapeseed	1	1	1	0	0	0	0	0	0	1	1	1
Sesame (Til)	1	1	1	0	0	0	0	0	0	1	1	1
Sunflower (Surajmukhi)	1	1	1	0	0	0	0	0	0	1	1	1
OTHERS												
Lemongrass	1	1	1	0	0	0	0	0	0	1	1	1
Marigold (Genda)	0	0	0	0	0	1	1	1	1	1	0	0
Sugarcane (Ganna)	1	1	1	0	0	1	1	1	1	1	1	1



CGIAR is a global research partnership for a food-secure future, dedicated to transforming food, land, and water systems amidst a climate crisis. Its research is carried out by 13 CGIAR Centers/Alliances in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector. www.cgiar.org. We thank all funders who support this research through their contributions to the CGIAR Trust Fund: www.cgiar.org/funders.

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