

# Intercropping in oil palm plantations

## A technical guide



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A vibrant, sunlit tropical garden scene. In the foreground and midground, there are large banana trees with broad, green leaves. To the right, there are plants with long, narrow, dark green leaves, possibly a type of palm or a tropical shrub. The ground is covered with dense, low-lying green vegetation. In the background, a person wearing a patterned shirt and dark pants is standing, looking towards the left. The overall atmosphere is bright and lush, with sunlight filtering through the leaves.

# Introduction



# About this guide

This guide provides examples of different forms of intercropping or agroforestry that differ in species, spacing and timing, ranging from regular arrangements to where oil palms and other crops are intermingled. It is intended to offer ideas and inspiration to extensionists in the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and the private sector partner Bidco Uganda Limited (known in Uganda as BIDCO), farmers they support, students of agriculture and other future investors in this industry.

The information in this guide offers government and private sector actors a wide range of advice to be given to new outgrowers who are being recruited in the existing and new oil palm growing areas, and to those who are preparing to replace old plantations with new ones. But ultimately, it can inspire all smallholder oil palm producers, with options to mix their desire to participate in economic benefits from oil palm, while also continuing with a diversified and resilient farming system which includes food and cash crops.

This guide builds on a study on oil palm intercropping in Uganda (Namanji et al., 2020), which was an assessment of farmer practices and the potential for expansion of intercropping practices. A research team conducted surveys

in Kalangala island where oil palm has been grown since 2002 in nucleus estates and by smallholder 'outgrowers' and independent farmers. The team found that many growers are already intercropping oil palm in many different ways with a combination of food and cash crops, and assessed the suitability of different intercrops, how they are combined, and views of smallholders on such agroforestry practices. This guide presents some of these field experiences, but more validation of these models is needed in order to be able to say with certainty if they are practical. What we do know is that farmers are trying them out on their own.

A review of literature from other oil palm producing countries offers experiences that Uganda can learn from, such as long term research trials' reports which present results on effects of intercropping on plantation productivity and annual crop yields. In general, research shows that there are no significant effects on palm oil yields when intercropped with annual crops in immature plantings, i.e., in the first 4 or 5 years of planting oil palm. Building from research as well as these practical field examples in Uganda, there are clear indications for advantages of intercropping in oil palm plantations. However, we stress the importance of further research and experimentation, especially on the long-term

trade-offs between palm oil production and intercropping yields and food security. Moreover, there seems to be very little information on comparative incomes, especially on the long term. This is especially important as studies on Kalangala, as pioneers of oil palm growing in Uganda, indicate that whereas oil palm brought economic benefits, it also reduced the production of food crops as land was turned to the sole production of oil palm. Subsequently, Kalangala islands went from being net exporters of food to being net importers (Ssemmanda and Opige, 2018, 2019), threatening local food security.

Over years, best agricultural practices for oil palm have been developed and promoted based on local conditions, supported

by the Food and Agriculture Organization of the United Nations (FAO), World Agroforestry (ICRAF), the Roundtable on Responsible Oil Palm (RSPO) and various governments, NGOs and certification bodies. The general principles of raising oil palm seedlings in nurseries, site preparation, planting, tending, harvesting and replacement are well documented (see 'Summary of agronomic practices' later in this section). This guide advises that such principles are maintained, but with intercropping of different types.

Last but not least, cropping systems evolve, and oil palm being new in Uganda, will need to incorporate indigenous knowledge and commonly used agriculture practices.

## **Agroforestry or intercropping – is there a difference?**

Strictly speaking (see the Glossary at the end of this guide), the term 'intercropping' is used to describe the system of growing of annual or short-lived crops together on the same piece of land. But, when one of these 'crops' are trees, whether they are young seedlings or mature trees, this is often called an agroforestry system. There is some overlap, but in this guide, intercropping is used in preference to agroforestry to describe the practices of mixing multiple crops together on the same piece of land.

*Intercropping and agroforestry offer many financial and environmental opportunities – a win-win option. It allows farmers to produce food crops to feed their families, and cash crops to diversify the sources of income especially in the face of dropping prices received for fresh fruit bunches. Other trees can also provide fuelwood and fruit, improving household resilience. In addition, increasing the number of different species being grown on the same piece of land also has benefits in terms of nutrient cycling, biodiversity and the provision of other ecosystem services.*

# What is oil palm?



Oil Palm (*Elaeis guineensis*) / Antique illustration from Brockhaus Konversations-Lexikon 1908 (©Adobe Stock)

African oil palm (*Elaeis guineensis*) is a tropical 'tree-like' plant which has for some time been grown for the industrial production of vegetable oil made from its fruit. It has a sister species, the American oil palm (*Elaeis oleifera*), but its fruit have a much lower oil content and are used only locally for artisanal oil production. African oil palm trees start fruiting 4-5 years after planting, and can produce good yields for at least 25 years. Trees will grow to 20-30 metres in height and with a straight trunk up to 75 cm in diameter. The prop root system is a dense mat mostly in the top 50 cm, with few roots penetrating deeper than 1 metre. This implies that crops feeding from below one metre may be good oil palm intercrops, while those planted too close to oil palm and feeding within 50cms depth would compete with oil palm plants.

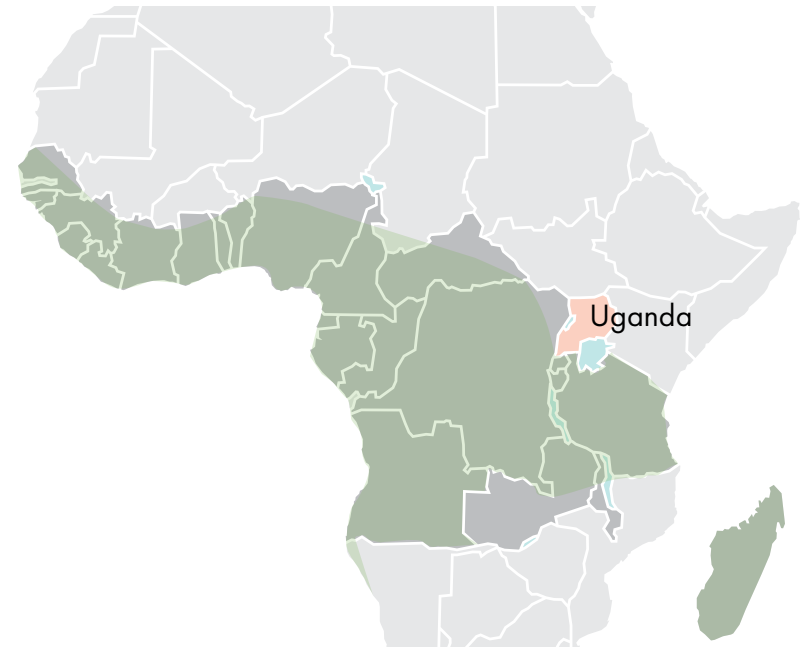
Oil palm is typically grown in monoculture plantations on large estates, sometimes over areas of 3,000 to 5,000 hectares or more, around a central oil mill to allow rapid industrial processing after harvesting. Oil palm can also be grown by smallholders, either contracted 'outgrowers' or independent farmers, usually to supply the main estate. The areas they cultivated can vary considerably in size, from 0.5 hectares to more than 25 hectares.

For optimal growth and production, oil palm requires high and year-round rainfall with little or no dry season and consistently high temperatures. Dry spells or temperatures that fall regularly below 18°C will affect growth and reduce yields. For best growth, soils should be deep and well drained. Production is also improved by the correct use and application of adequate quantities of mineral fertilizers and/or animal manure, and the effective control of pests and diseases.



The African oil palm is naturally present and sometime abundant in lowland rainforests in West Africa and Central Africa, often in coastal forests from Senegal all the way around to Angola, and including much of the Congo Basin, Tanzania and even across to Madagascar (Pasiecznik, 2008). But African oil palm is not native to Uganda, though the exact limits to the native range are disputed, as are those of many plants that have been so widely used by man for many centuries.

African oil palm was introduced from West Africa to South America in the 1600s and 1700s along with the slave trade, and to Indonesia and Malaysia in the 1800s, with the first estates for palm oil production established there in 1910-20. It has also been widely introduced in the Pacific where it spreads naturally and is even considered an invasive species in some islands (Pasiecznik, 2008). Today, it is likely to be present in almost every country with a humid tropical climate. In Uganda, the first estates were planted in 2002, in Kalangala island.



Native range of African oil palm (*Elaeis guineensis*)

# Oil palm's introduction into Uganda

Agriculture is the most important sector in Uganda's economy for food and nutritional security, rural employment and income, and for producing raw materials for industry and for export to regional and international markets. It employs more than 70% of the working population, and contributes 24% to GDP (UBOS, 2016). The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is responsible for managing and coordinating agricultural policies and interventions. It does so through its agencies, local governments, farmers and farmers' organizations, other ministries, departments and agencies, the private agribusiness and agro processing sector, civil society, development partners and academia.

In its 2013 policy the ministry stated that agricultural development strategies will be developed and pursued according to different agricultural production zones through a commodity-based approach (MAAIF 2013). Commodities that are best suited for each zone will receive public sector support for the purposes of food security and for commercialization, with support for the development of viable agro-industrial centres.

Other objectives of the agricultural policy include increasing household food and nutritional security through expanded production, and improving incomes to support the purchase of food. To realize these, the government is promoting agricultural enterprises that enable households to earn incomes and to become a part of the value chain. Uganda imports a lot of vegetable oil, and to begin with the government promoted oil palm production for import substitution. Other crops were considered at first, but the government began to invest more in oil palm after it was realized that even poor yielding palm trees produce much more from a piece of land than annual oilseed crops do.

Based on the climate, the best area for the cultivation of oil palm in Uganda was considered to be the Lake Victoria islands, and the Ssese Islands of Kalangala District were selected for the establishment of the first plantations in 2002 (IFAD, 1997). Now the area under oil palm is planned to be greatly expanded, to include more islands in Buvuma district, and several other new 'hubs' on the mainland that are being prepared for oil palm production, including Mayuge, Buikwe, Masaka and Kiryandongo, with a total of 40,000 hectares targeted in 14 trial districts.



From the outset, the government worked with the private sector partner Bidco Uganda Ltd, supported by substantial investments by the International Fund for Agricultural Development (IFAD). The model applied includes nucleus estates established and managed by Oil Palm Uganda Ltd (OPUL), with additional plantations managed by smallholders through an outgrower scheme. OPUL discourages intercropping in oil palm plantations, because it is assumed that any intercrops will utilize some of the fertilizers meant for oil palms, therefore reducing yields. Nucleus estates are thus exclusively pure monoculture oil palm plantations, and outgrowers and independent farmers are told to do likewise. However, a recent survey showed that many farmers also like to intercrop with other food and cash crops, and more are interested (Namanjii et al., 2020).

Plantations vary in sizes. In Kalangala, the distribution of such farms depended on a number of agroecological, demographic conditions, as well as land availability. The nucleus estates are exclusively run by the private sector (OPUL) with other outgrowers annexed to the established plantations. Oil palm plantations in nucleus estates are usually better managed than those in by outgrowers or independent farmers, and which is reflected in significant differences in yields per hectare.



*Districts in Uganda where oil palm is already grown (Kalangala), is planned (Buvuma) and on the mainland where expansion is being considered.*

*Source: modified from ©OpenStreetMap*

# Common features of palm oil production in Uganda

- *The sector is supported by multinationals with big investments*, and in Uganda through an agreement between the Vegetable Oil Development Project (VODP) as the government representative under the arrangement, and the BIDCO consortium consisting of BIDCO Uganda, Oil Palm Uganda Ltd. and Wilmar (BIDCO-Wilmar JV).
- *Oil palm production requires large areas of land*, and the government is tasked with availing land for the purpose of establishing oil palm plantations in Uganda, which often involves large scale land acquisition, deforestation, or de-gazetting on forest reserves.
- *Oil palms are long-lived species*, with planning and investment based on a rotation period of 25 years, after which plantations can be replanted with different crops or in alternative intercropping or agroforestry combinations.
- *Oil palm is usually grown in pure plantations as monocrops*, with standard spacing in nucleus estate of 9x9x9m, and with outgrowers as is the case with Oil Palm Uganda Ltd (OPUL).
- *Implementation is supported as a government priority*, with oil palm introduced by government to help achieve the overall goal of inclusive rural transformation.
- *Production of oil palm is more labour-intensive than cultivation of traditional crops*, with the experience from Kalangala showing that introducing oil palm led to the mass movement of people to or from the district, with islanders being replaced by non-natives.
- *Oil palm leads to improved incomes for producers and associated workers*, which has brought substantial and transformative economic benefits compared to traditional systems as in Kalanga District for example but the social and environmental outcomes are not always positive.
- *Oil palm is often accompanied by infrastructure development*, and in the four new hubs, the National Oil Palm Project (NOPP) promises to construct and maintain roads and electricity connections that are critical for effective oil palm production and marketing.



# Moving from pure palm to mixed systems

The National Agriculture Sector Strategic Plan stated that the production of oil palm requires economies of scale, and it is currently dominated by nucleus estates. But due to the interest shown by smallholder farmers, there is significant potential for more farmers to improve their household incomes by producing oil palm. But this requires that the deep-rooted subsistence farming culture must be carefully considered, in such a way that their core system is not ignored. And here, intercropping can play a very valuable role, in allowing farmers to produce oil palm and their usual food and cash crops.

A look at what has been tried elsewhere in the world, and where oil palm has been grown for much longer, shows that there are many different ways to produce oil palm and many different other crops from the same piece of land. See for example, some stories in Jezeer and Pasiecznik (2019), 'Exploring Inclusive Palm Oil Production, *ETFRN News* #59.



## Advantages and disadvantages of oil palm monocropping, compared to intercropping

### Advantages of monocropping

- Monocropping maximizes oil palm yield, and as the private sector partner Oil Palm Uganda Ltd. (OPUL) produces only palm oil, this is its focus.
- Marginal soils may not easily support multiple cropping systems, and most oil palm in Kalangala for example is grown on hilly or less fertile soils.
- Nucleus estates are designed so heavy machinery can be used, and companies consider that intercrops may affect mechanical tending or harvesting operations.
- Oil palm competes strongly with other plants for light and soil nutrients, and the fibrous roots inhibit the growth of crops immediately around them.
- Good agricultural management of oil palm as a monocrop imposes strict agronomic practices from transplanting to first fruiting, as recommended by the private sector.

### Advantages of intercropping

- Not 'putting all your eggs in one basket' is one important reason why monocropping oil palm is unpopular with many farmers.
- Intercropping allows farmers to diversify production of food, fodder, fuel and timber, as a guarantee against crop failure or the falling or fluctuating prices they receive from the sale of fresh fruit bunches.
- Intercropping with legume crops adds nitrogen to the soil, reducing the need to purchase and add mineral fertilizers.
- Mixed cropping is thought to reduce the incidence of pests and diseases, both on oil palm and the associated crops.
- More diverse cropping systems avoids having large areas with only a single crop (oil palm), thereby increasing biodiversity and ecosystem services, improved local microclimates, and can make the landscape more resilient to climate change.



# Benefits from growing more than just oil palm on a piece of land

In Uganda, Kalangala is still the only place where oil palm is grown extensively. So, it is the only place where farmers have experimented and where we see what has been tried. In Kalangala, oil palm is intercropped in different ways and with different companion crops. Intercropping with food crops gives farmers more options to diversify. A main advantage of intercropping is the possibility of producing more from any given piece of land, by achieving more efficient use of the available resources that would otherwise not be fully utilized by any single crop alone.



### *Notes for farmers*

- The more food, fruit, fodder and fuel you can grow yourself makes you more self-sufficient and more resilient in case of price fluctuations, or if a virus comes along...
- You can easily grow many different crops and trees within and around oil palm trees and plantations.
- And how far apart you plant oil palms at establishment can then make a big difference in what other crops you can grow for the next 25 years...
- Or at least don't turn over all your land to oil palm and keep some land for growing other crops for food or income.
- In other countries where they have planted oil palm for much longer than in Uganda, people have found different ways to make more money from diversifying production from the same piece of land.

### *Notes for extensionists, from the ministry, private sector or producer organizations*

- Intercropping between young oil palms in the first five years after planting is a win-win option, producing food and cash crops, and helping to keep the palms weed-free.
- Ad hoc intercropping in mature plantations can also diversify production when organized, but with a smaller range of possible (more shade-tolerant) crops.
- Double row alley systems seem to offer the best opportunities, and allow a wider choice of crops and trees and throughout the usual 25-year oil palm production cycle.
- Including oil palm in smallholder homegardens (multi-layered agroforestry systems) can extend production to new areas, and allow more farmers to produce and supply fresh fruit bunches from in and around their homesteads.



An aerial photograph showing a vast, dense plantation of palm trees stretching towards the horizon. The trees are arranged in a highly organized, grid-like pattern, characteristic of monoculture agriculture. A narrow, straight path or road is visible, cutting through the center of the plantation. The ground between the trees appears to be reddish-brown soil. In the far distance, there are low, hazy hills under a blue sky with scattered white clouds.

# The monocropping model



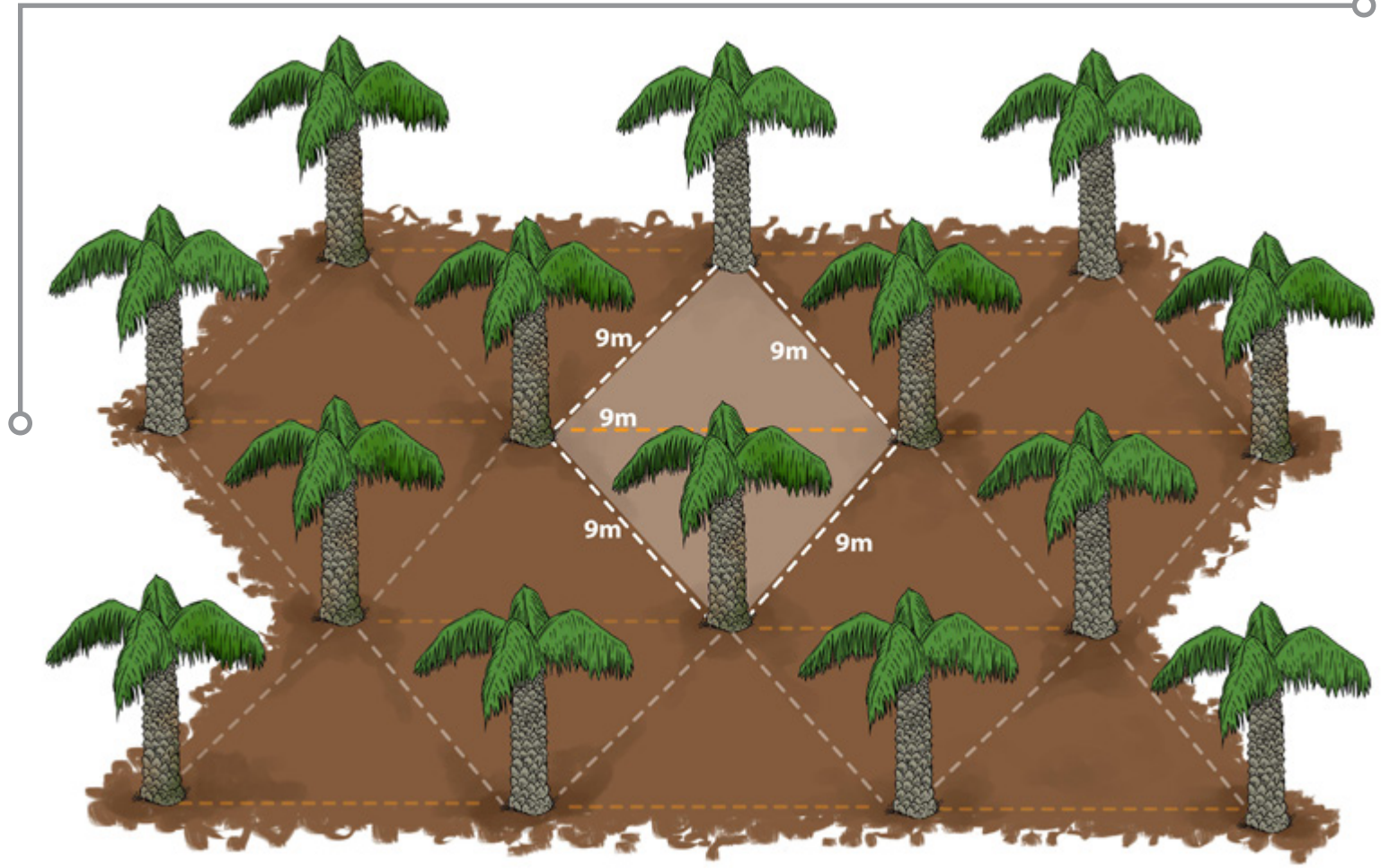
# The Ugandan model

Monocropping is the usual production system on extensive plantations, and which is easier for large-scale owners to manage. Many smallholders plant oil palm as a monocrop even on the small areas of land that they manage, sometimes with success, high yields and good profits. But without access to other land, they may sacrifice areas that were previously used to produce food crops for family consumption or for sale. So, for farmers with small plots, mixed cropping systems are appearing to be more attractive than the monocropping model currently promoted by governments and private companies.

But, independent of farm size or farmer wealth class, Oil Palm Uganda Ltd. (OPUL) encourages all farmers to plant their

land in the same way as is done in the nucleus estates, i.e. as monoculture. This is because maximizing the production from outgrowers is integral to the overall project design. As such, the government, the donors and the private sector see the entire economic development process as dependent on oil palm yield, and they have not adequately considered the many other social and environmental factors that are essential to success (Ssemenada and Opige, 2018; 2019). It is expected that smallholders operate their farms as entrepreneurs, but in the context of today's modern markets, smallholder farmers have to overcome considerable constraints in meeting their demands, and face many risks in doing so.

A typical oil palm plantation at 9x9x9m spacing as recommended by BIDCO/OPUL.



# Summary of agronomic practices for oil palm

- Do not plant on slopes of more than 25 degrees, unless the land is terraced.
- Holes should be prepared in advance. Wet the soil before seedlings are planted.
- Ensure that all weeds are removed during land clearance.
- Spacing pattern may vary, but 9x9x9m is preferred in Uganda (60 palms per acre, or 150 palms per hectare).
- Sowing legume cover crops (e.g. *mucuna*) soon after clearing reduces weed regrowth and improves soil fertility.
- At planting, top soil heaped on the side during digging should be put in the hole first.
- During the first year, young oil palm plants must be well weeded and tended. Circle weeding or ring weeding is essential to reduce competition from other plants.
- Restrict herbicide use to a minimum, i.e. circles around trees or along harvesting paths.
- After weeding, apply fertilizers, preferably at the end of the rainy season, along with mill residues (e.g. empty fruit bunches, boiler ash), and/or animal manure if available.
- Removing all dried leaves from close to the stem of each palm using a sharp cutlass is important, but being careful

not to wound trees as this increases attack by palm beetles and weevils. Also cut any lianas or ferns that may be growing in the palm tree.

- Frequently inspect trees for any pest or disease attacks, and general health and growth, and use 'integrated pest management' (IPM) where possible to minimize pesticides use.
- Maintain native species along watercourses and planting them where they are absent are important to conserve biodiversity on and around farms.
- Farming must be profitable but also resilient to shocks such as price fluctuations, with farmers maintaining some food production for household use and others crops for sale.

See also Manuals on best management practices (BMPs) for oil palm, e.g. by the Roundtable on Sustainable Oil Palm (RSPO), amongst others.





# Growing oil palm with other crops



# A) Intercropping in plantations with standard spacing

## (i) In young plantations

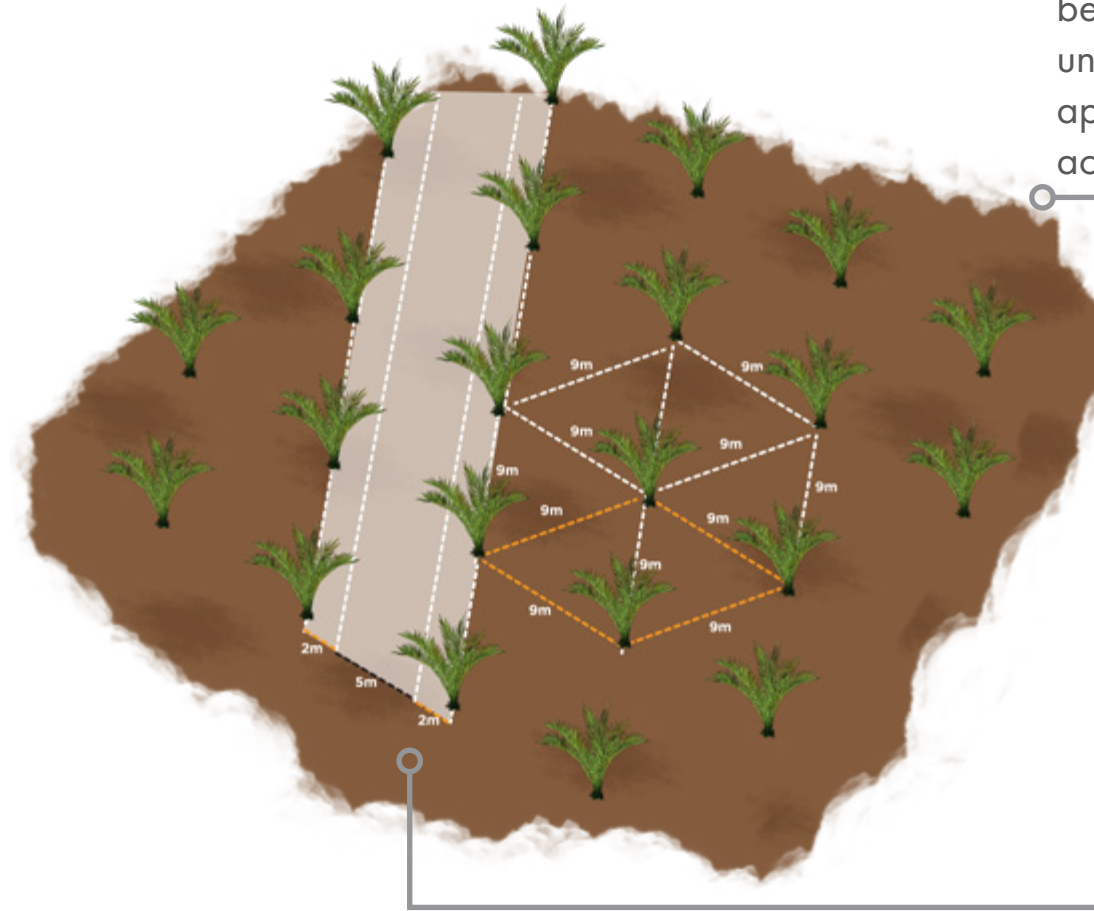
All smallholder oil palm producers can grow crops in between young palm trees during the early stages of development (up to 5 years), or allow other farmers to grow crops between young palms on their land. In addition to income gained before oil palm harvest, intercropping can also significantly reduce the cost of weeding, and manuring the crops can further help early growth of the young oil palm plants. The choice of crops vary from country to country.

The Kalangala experience has shown farmers have learned themselves, and intercrop with banana, cassava, maize, sweet potato, yam, beans and other common annual crops grown in central Uganda. These crops also need weeding, and more often and much more precisely than oil palm. Blanket spraying will thus not be possible. But of course, when more land is occupied by food and other cash crops, these will need weeding less just like when light is limited when the canopy becomes closed.

## Advantages

- Annual crops (maize, soybean, peanut...) or multi-annuals (banana, pineapple...) all help to meet household food needs, with income from sale to ready markets.
- This narrows the income gap between planting and first oil palm harvest (3-5 years), with farmers able to sell produce as they wait for palms to mature.
- When intercropped with legume crops (beans, peas, soybeans), these enrich the soil from nitrogen-fixation and provide nutrients to the palm trees.
- Sowing a legume cover crop such as *mucuna* also reduces soil erosion, which is especially important on sloping sites.
- Intercropping between young oil palm also means that additional weeding is only needed immediately around each tree.
- There are no reported negative effects on oil palm growth during the first 5 years.

## How it is done

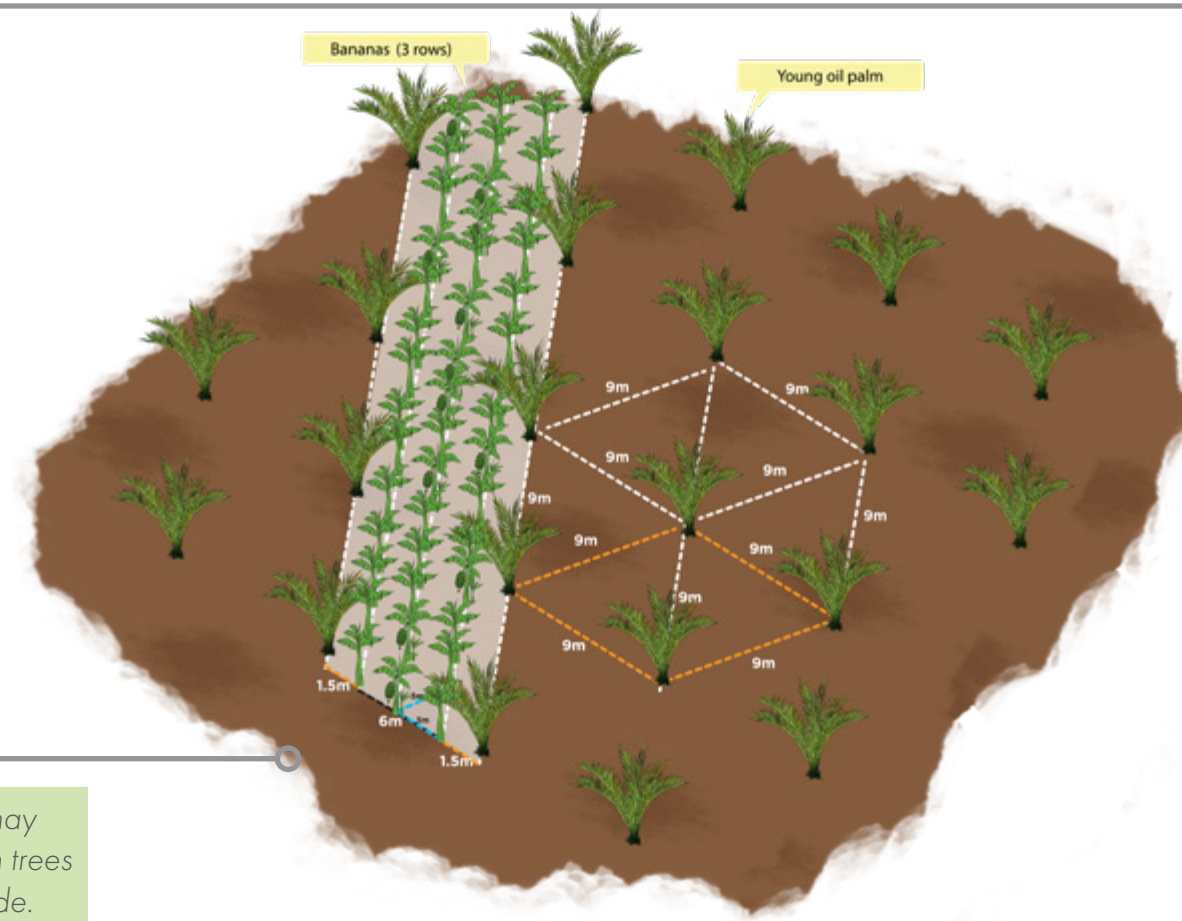


The recommended spacing between oil palm plants remains unchanged at 9x9x9m, or approximately 60 palms per acre, or 150 palms per hectare.

Leave up to two metres around each young oil palm free, and weeded when needed. This leaves rows of approximately 5m wide for intercropping, with best yields immediately after planting oil palm.

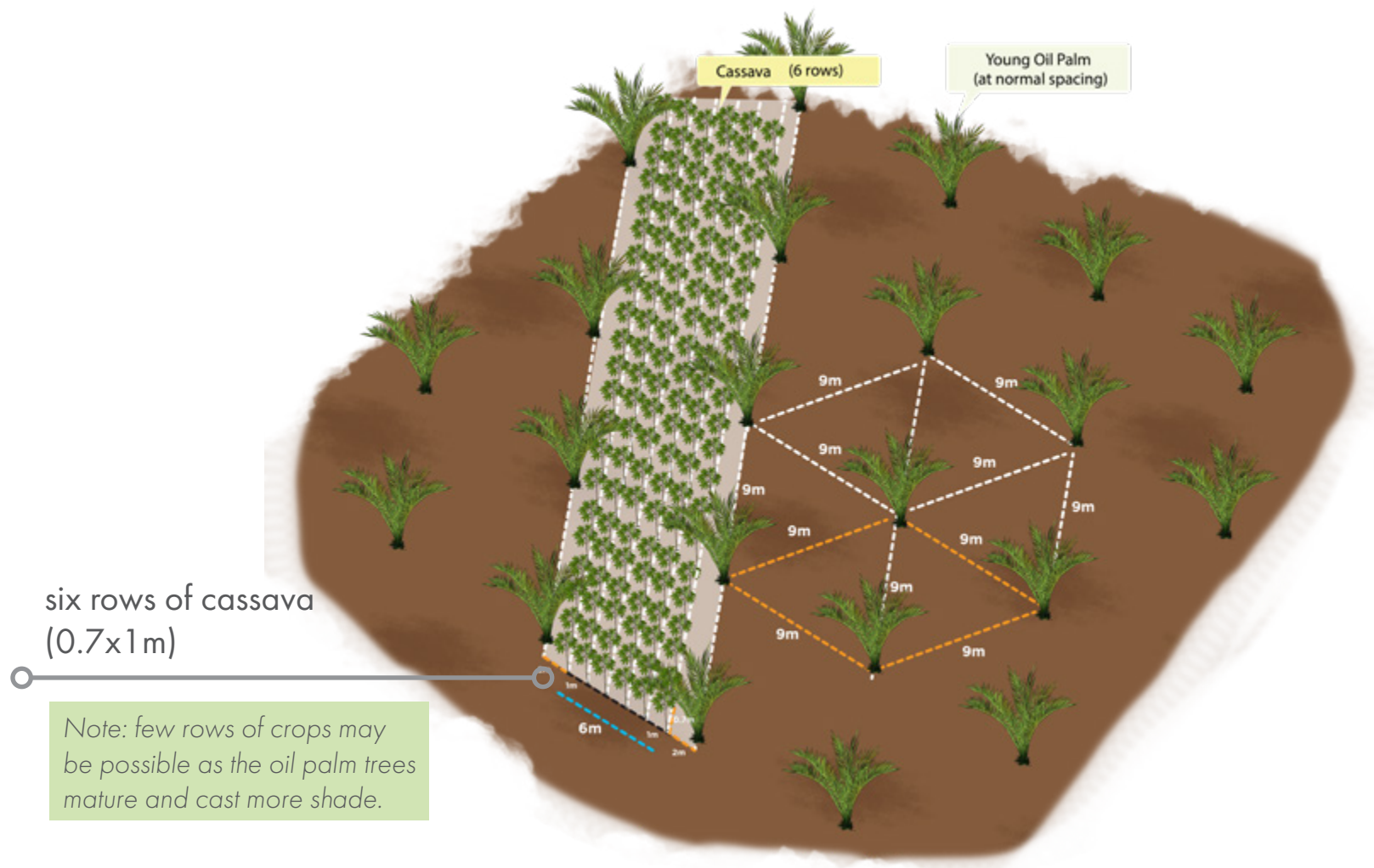


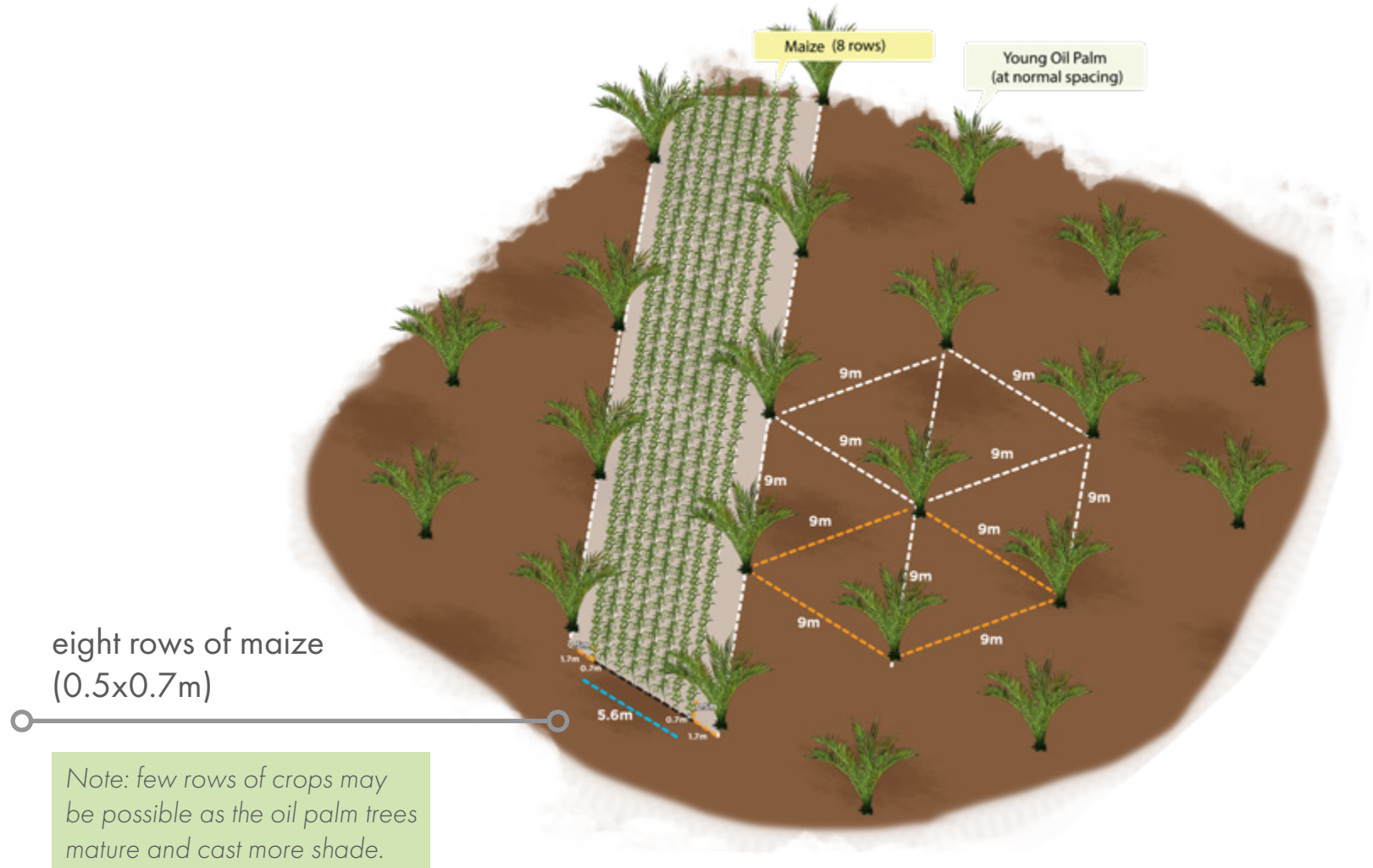
The choice of crops may be based primarily on family needs, with the three crops chosen here being the dominant food crops in Uganda. It is possible to grow different crops, and not only in rows, but also between palm trees.



three rows of banana  
(3x3x3m)

*Note: few rows of crops may be possible as the oil palm trees mature and cast more shade.*







## Intercropping young oil palm with other crops around the world - Malaysia



Growing banana between young oil palms in Johor, peninsula Malaysia.

*Photo: Maja Slingerland.*

## Intercropping young oil palm with other crops around the world - Indonesia



A farmer shows the food crops he produces as he moves from one young plantation to another to grow vegetables in Jambi province, Sumatra, Indonesia.

*Photo: Thijs Pasmans [Source: Pasmans (2017)]*





A large farmer allows smallholders to grow rice in his young oil palm plantations, south Sumatra.

*Photo: Thijs Pasmans [Source: Pasmans (2017)]*



## (ii) In mature plantations

Yam, vanilla and cacao are shade tolerant crops, and smallholders even plant these in shaded areas. These crops can be grown within oil palm plantations, though farmers may choose to prune the nearby palm trees to remove more leaves and allow in as much light as possible without reducing the growth or yield of oil palm. However, cutting too many leaves will reduce palm growth and yields, so farmers will have to experiment as to the optimum relationship between the level of pruning, palms yields and the production of intercrops.

In Uganda, this is practiced to some extent, but in an ad hoc way with yams or cacao grown in patches where there are no oil palms or where trees have died. Even so, this will help fill gaps, but the cacao will not yield as much as in open spaces. Growing in rows between wider-spaced palms would make the crops easier to manage and decrease competition.

*These examples are based on farmer field experiences in Uganda. More research is needed on the trade-offs between (long-term) yields of oil palm and intercropped crops or trees, as well as impact of management practices such as shortening or reducing palm tree leaves.*

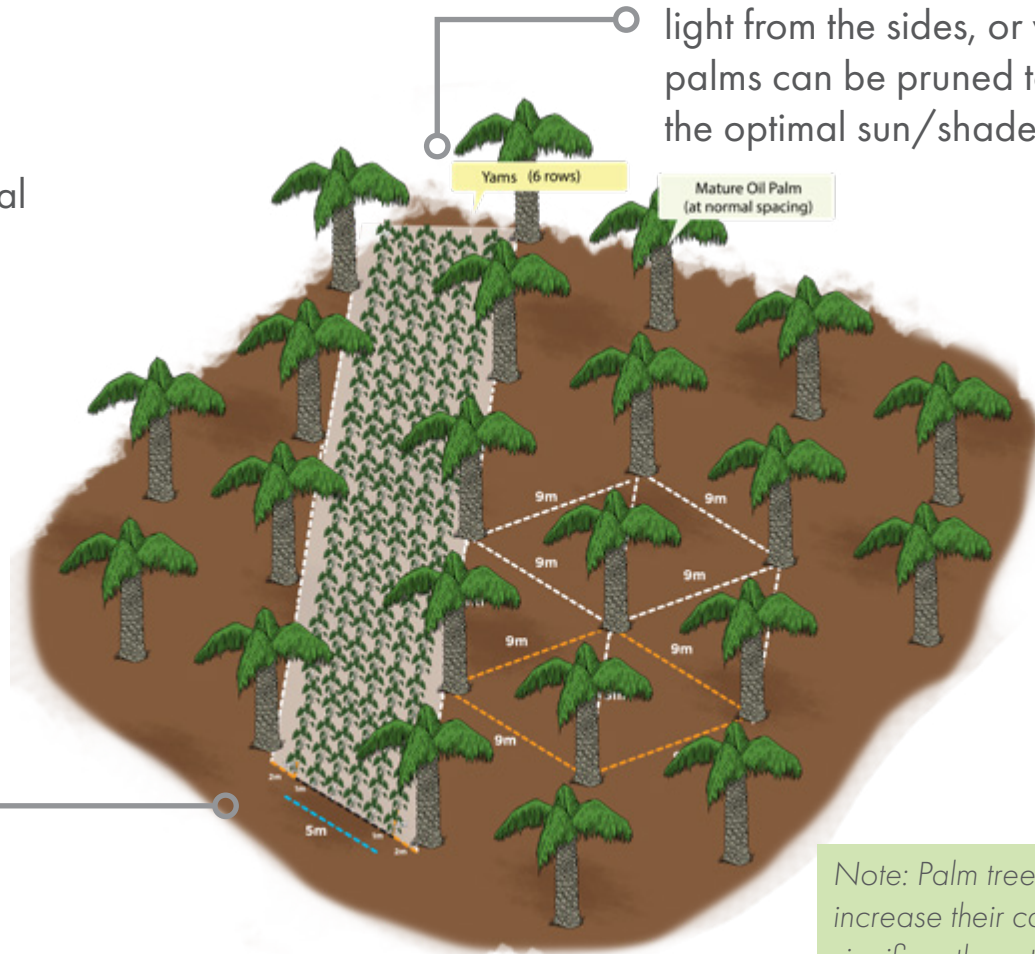
## Advantages

- Shade tolerant crops provide good intercrops in established oil palm plantations where other crops will not be able to grow well.
- Yams provide food for both home consumption and possibly for sale.
- Cacao and vanilla are high value crops with ready markets, providing alternative income.
- Cacao can be planted after oil palm has established and may not impact oil palm growth but lower cacao yields might be expected compared to cacao monoculture plantations.

## How it is done

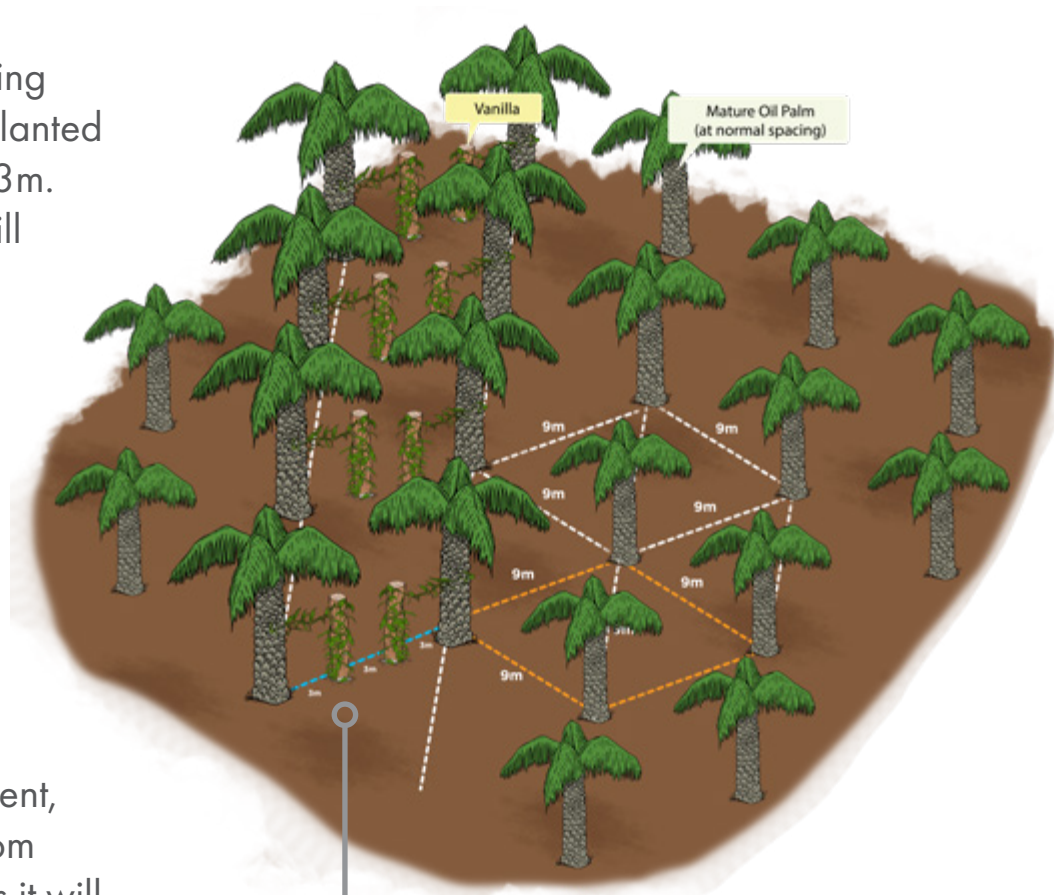
Mature oil palm at normal spacing (9x9x9m) and rows of yams at least 2 metres from the oil palm, yams can be planted at 1x1x1 m and this will allow rapid growth and easy management of the crop. Yams may also perform better in gaps, as too much shade will reduce yields.

Consider areas that let in more light from the sides, or where oil palms can be pruned to achieve the optimal sun/shade ratio



Note: Palm trees will increase their canopy cover significantly as they mature.

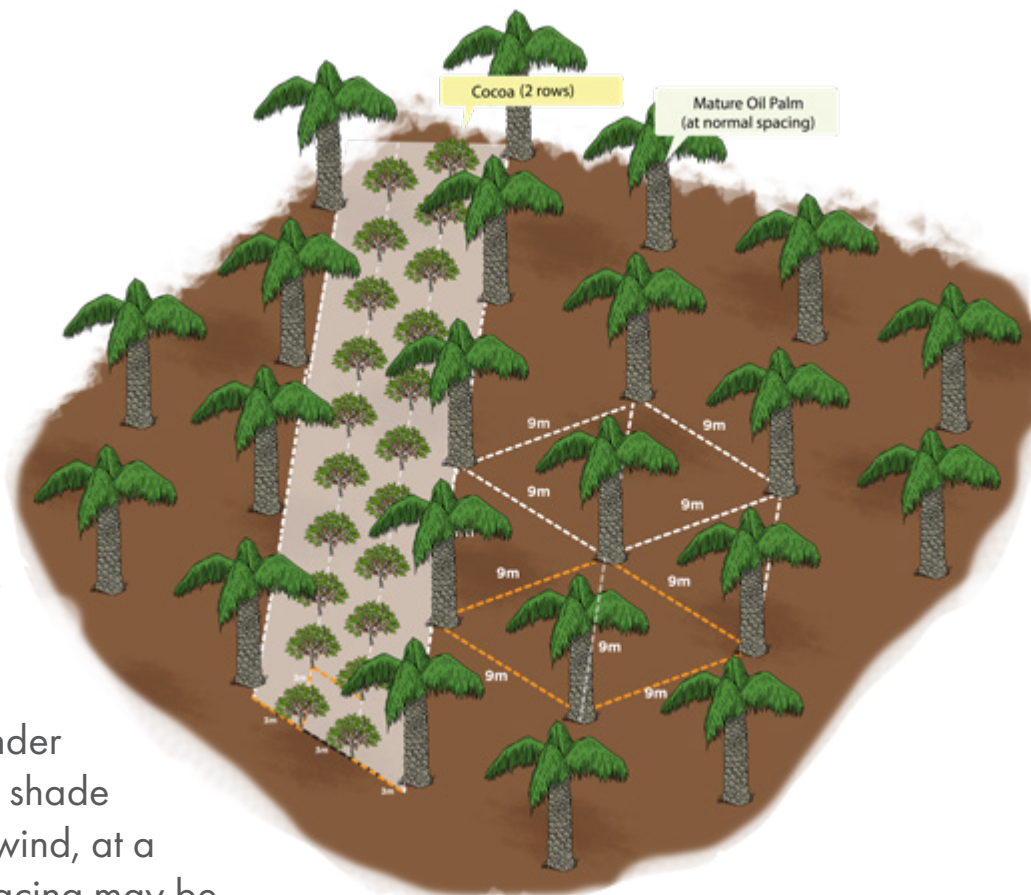
Mature oil palm at normal spacing (9x9x9m) and rows of vanilla planted next to support species at 3x3x3m. The primary shade for vanilla will come from the support species they will climb up, and their selection and management is nearly as important as the care of the vanilla vine itself as they will also need water and nutrients, so more drought-tolerant nitrogen-fixing species such as *gliricidia* or *calliandra* may be preferred. Planting vanilla requires investment, and advice should be sought from extentionists before planting, as it will likely perform better in gaps or in double row systems.



Note: Palm trees will increase their canopy cover significantly as they mature.



Mature oil palm at normal spacing (9x9x9m) and rows of cacao. Cacao can be planted under mature tropical trees that provide shade and shelter from the sun and the wind, at a spacing of 3x3x3m. But wide spacing may be needed. Cacao requires different treatment to annual crops, and advice should be sought from extension agents before farmers make such a long term investment. (e.g. Yussoff et al., 2015).



*Note: Palm trees will increase their canopy cover significantly as they mature.*

## B) Double row alley systems

Oil palms are planted closer together within rows – 6 metres apart and not the usual 9 metres. Then after two rows at the usual 9 metre apart, broader 'avenues' are left between each double row of oil palms. This gives a density of 136 palms per hectare compared to about 150 in monoculture. This means 10% less oil palm trees per hectare, but allows farmers to grow other crops at the same time throughout the 25-year cycle. Studies show relatively little decrease in oil palm yields per tree in this system, while farmers also benefit from additional income and food security that intercrops provide.

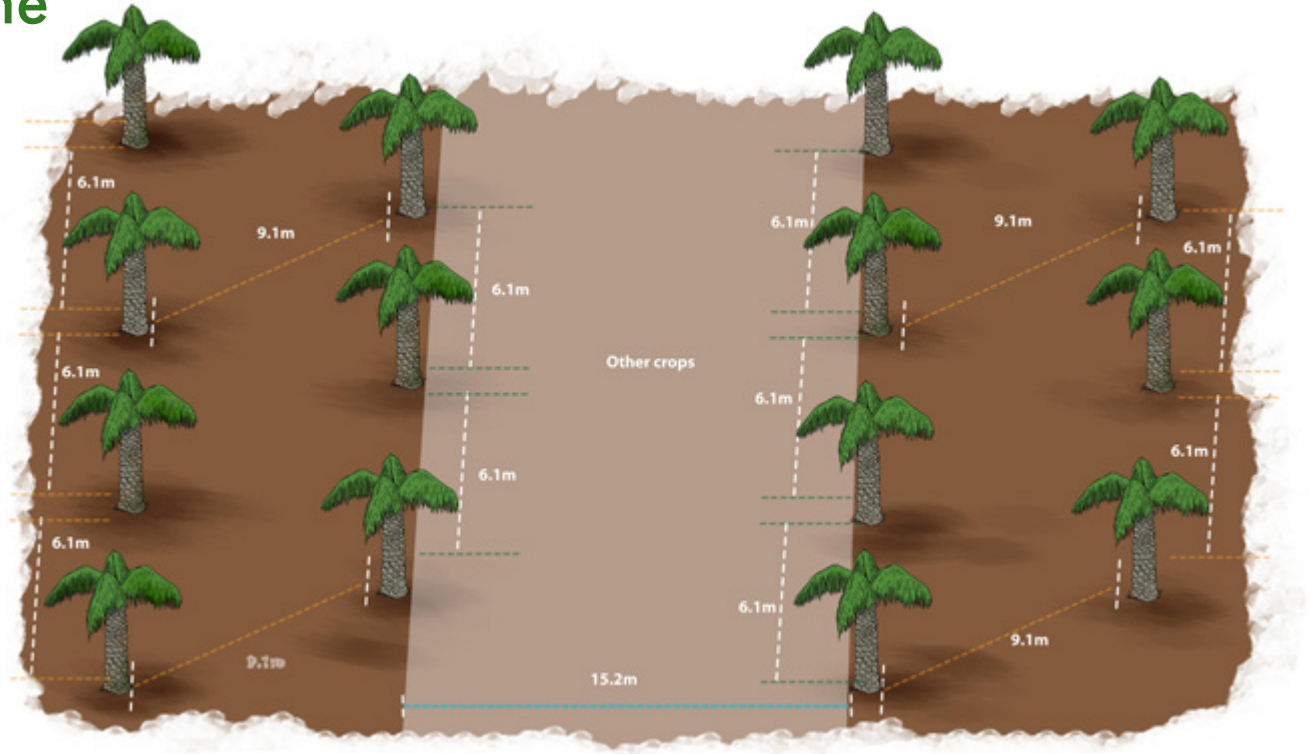
This can also be a remedy for land shortage and negative environmental issues from oil palm, and it is important that MAAIF, BIDCO/OPUL and KOPGT appreciate the advantages and encourage integration of oil palm into landscapes other than monoculture plantations at the moment of planting or replanting, as existing plantations cannot be converted.

*Advice should be sought from professional foresters regarding what trees would be good to plant, and at what spacings and combinations, depending on what the farmer needs (e.g. income from timber or firewood for domestic use, or both).*

### Advantages

- Double row alley systems allow farmers to intercrop permanently with little impact on oil palm yield.
- It allows farmers to have a wide choice of crops including high value species, while meeting minimum requirements for light, water and nutrients for oil palm and intercrops.
- Farmers could also integrate other trees to supply timber and fuelwood. For commercial timber species, good results have been achieved with intercropping with meranti (*Shorea* species) in Indonesia for example, but teak (*Tectona grandis*) is more competitive.

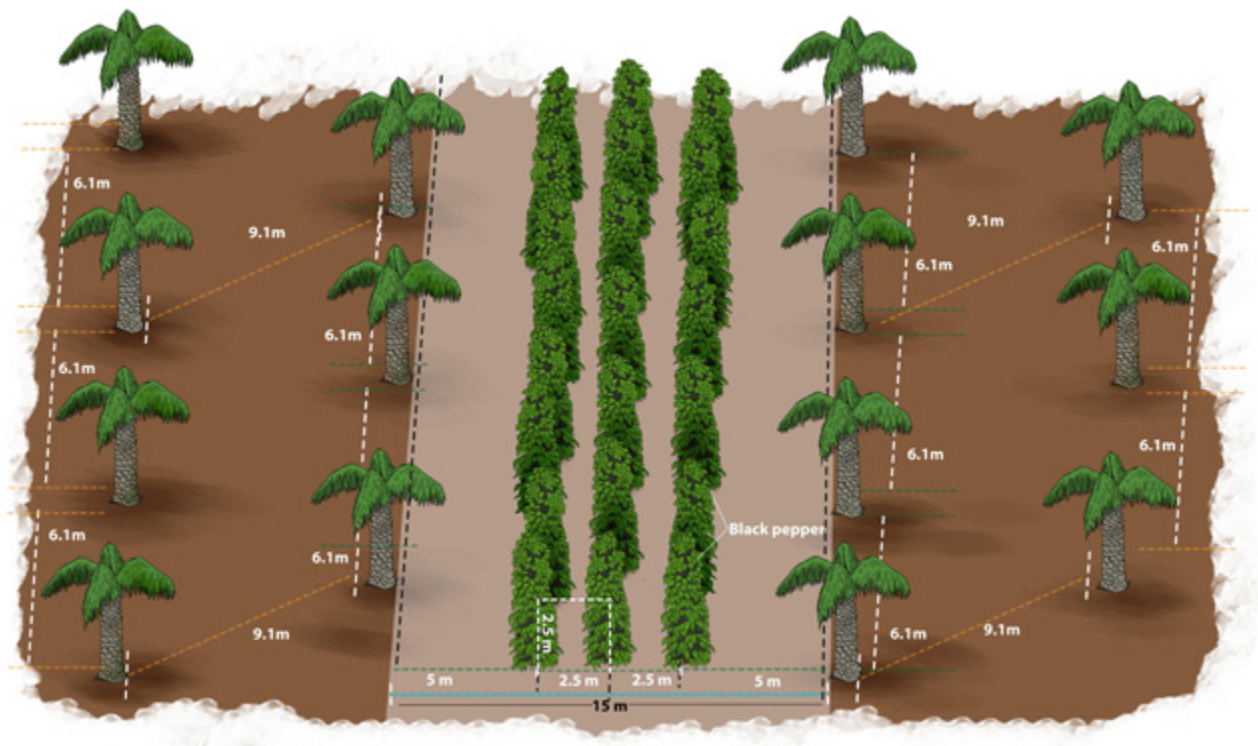
## How it is done



A double row alley system, with the avenue used for growing food or cash crops. Each avenue has two rows of oil palm 9 m apart, but with only 6 m between the trees in each row, leaving 15 m wide alleys between each double row, to grow other crops – with 136 plants per hectare compared to 150 per in the normal 9x9x9m system.



In between the avenues, one can plant any crop at required spacing. For example, it can be planted with forage crops to integrate livestock rearing or appropriately using space to grow other annual crops for food production.



Black pepper can be planted in the avenue in three rows and managed as a perennial cash crop alongside oil palms in the double rows.

## Double row alley systems around the world - Malaysia



Double row alley intercropping in Malaysia, with cassava (left) and black pepper (right).

*Photos: Maja Slingerland.*

## C) Planting with other trees

### (i) Boundary planting

Boundary planting with certain tree species is promoted as an agroforestry model, with trees and oil palm in one plantation. It is also done in drier areas to conserve moisture and reduce the hazards of wind erosion, and to protect from salt spray in coastal zones. But, literature shows growth of some tree species may suffer from competition from oil palm (Muryunika, 2015), and advice of local forestry services on the choice of species is important (Teuscher et al., 2015).

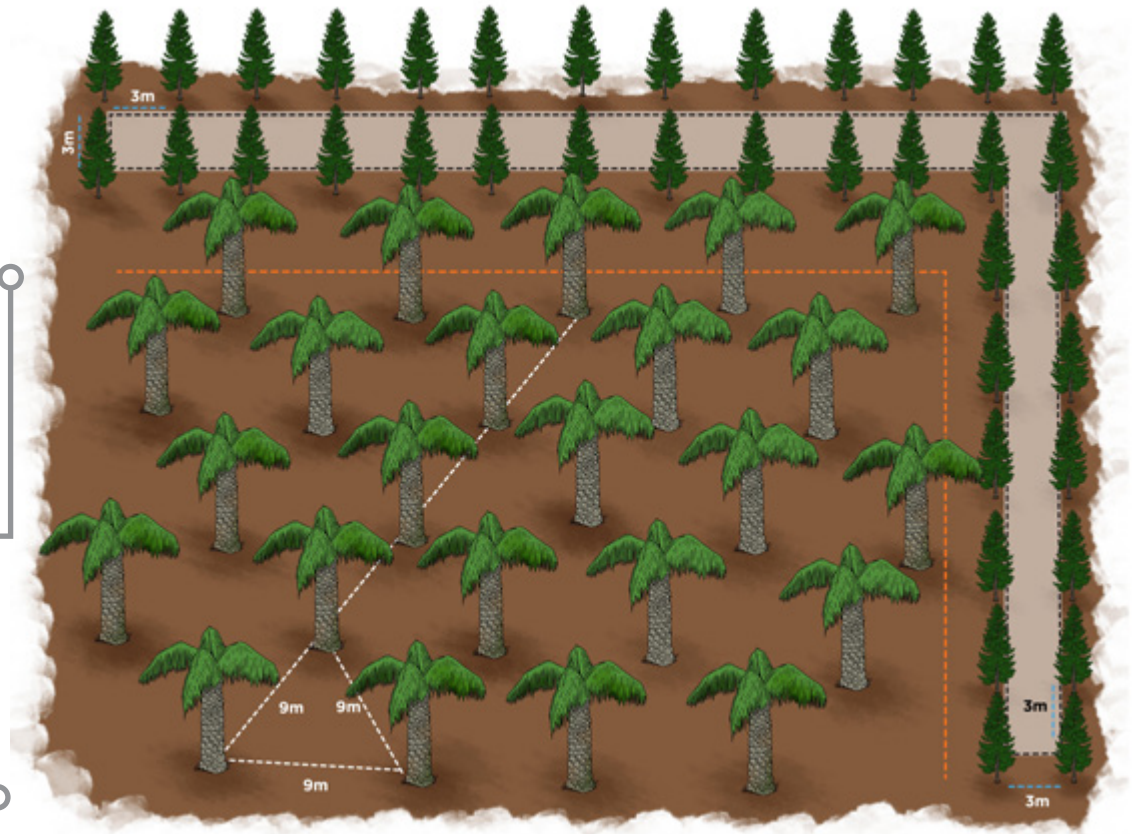
### Advantages

- Trees provide valuable additional income from timber sales with returns in 5 to 30 years, while also providing fuel wood and other products depending on the species.
- Boundary trees clearly mark out land ownership thereby reducing conflicts.
- Species mixtures also improves biodiversity, could reduce pest and disease attacks, and improves the environmental services of a plantation.



## How it is done

When planning to plant oil palm at the recommended spacing, an agreed strip up to 10 m wide is reserved around the plantation to plant high value and preferably native trees.



If land is available at a plantation's edge, trees can be planted any time in the palm cycle.

Plant in lines following recommended guidelines provided by the National Forest Authority, e.g. *Maesopsis eminii* at 10x10m, pines at 3x3m, *Markhamia* at 2x2m

## (ii) Interplanting other trees (agroforestry)

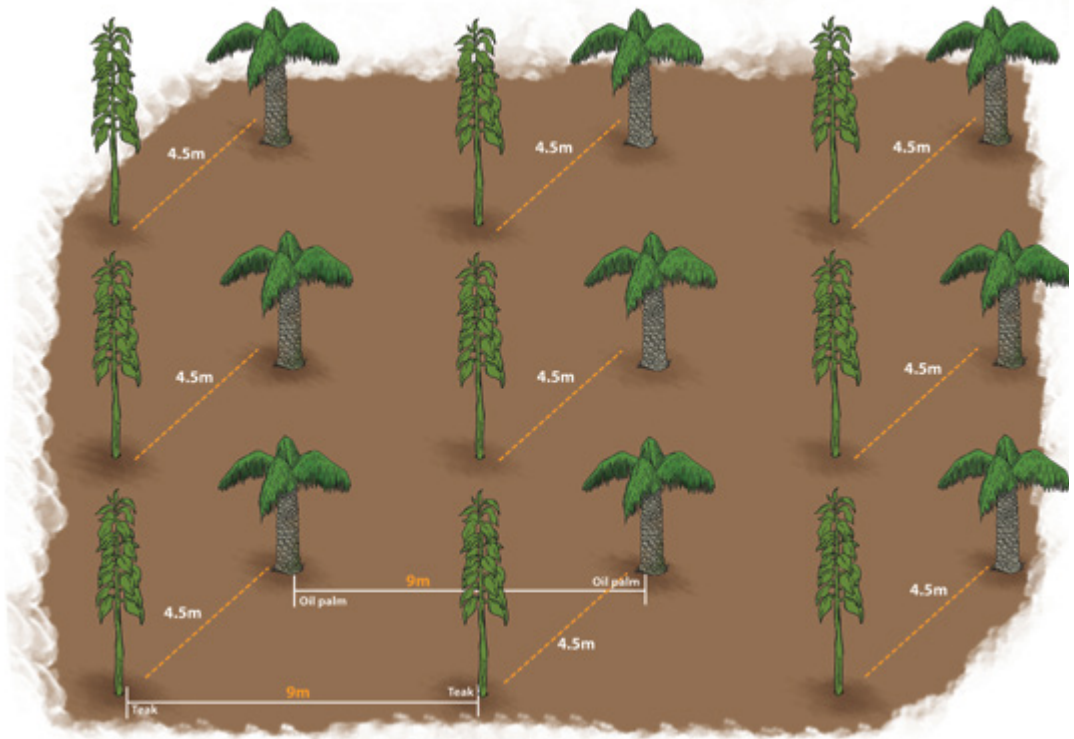
Different tree species have also been used as intercrops in oil palm in other countries. But these do tend to have variable effects on the performance of oil palm, and combining trees with oil palm generally seems to lead to yield penalties in oil palm which then need to be compensated for by revenues generated by the intermixed agroforestry trees, and/or other benefits in terms of income resilience and non-monetary environmental benefits.

### Advantages

- Trees provide valuable additional income from timber sales, while also providing fuelwood and other products depending on the species.
- Trees have added advantages for on-farm and environmental conservation, with further ecosystem services provision (fuel, microclimate, etc.).

## How it is done

For interplanting, establish oil palm at the recommended (9x9x9m) spacing, and plant other trees in alternating rows – or establish oil palm within existing plantations of other species.



However, research shows strong competition, with alternative rows of teak can strongly depress oil palm growth and establishing them within plantations of other trees also depends on spacing as young oil palm is susceptible to shade. Underplanting oil palm in old rubber plantations has been seen to significantly reduce growth and yields, so advice should first be sought from local forestry experts.



## Mixing oil palm and other trees - Indonesia



Oil palm and meranti (*Shorea leprosula*) timber trees interplanted in Sumatra, Indonesia.

Photo: Budiari.



Young oil palm growing under rubber trees, Indonesia.

*Photo: Thijs Pasmans*



## D) Homegarden agroforestry

Homegardens are multistory combinations of various perennial and annual crops grown simultaneously and often with no distinct arrangements, with domestic animals usually grazing underneath. These are typical only in very high rainfall areas with constantly high temperatures. Where oil palms are native in humid African climates, they are often components in such systems, and where a few trees are enough to meet a family's own oil requirements, being processed in artisanal methods at home or locally.

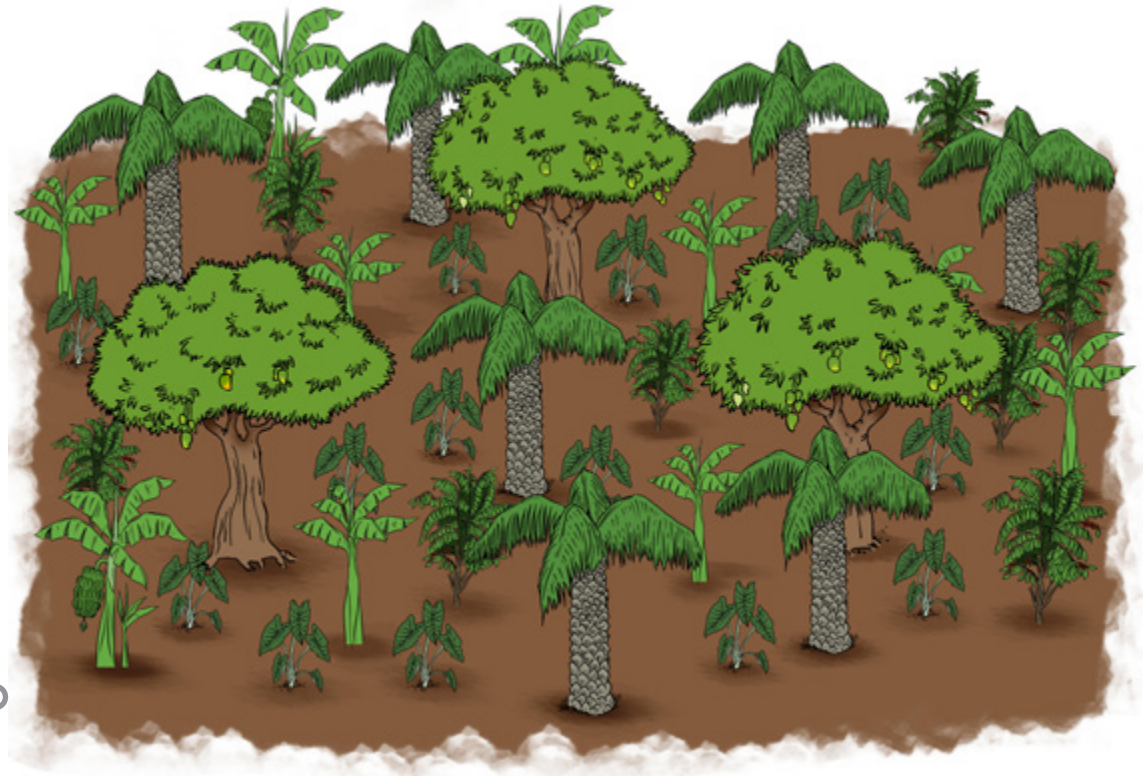
### Advantages

- Homegardens are able to support many livelihood strategies especially with smallholders who have limited access to land (and other sources of food, feed, timber, etc.).
- Such mixed agroforestry produces many different products, providing food security, diverse income options, and resilience in case of one crop failing.
- Income from selling oil palm is seen as important, additional to that from other crops, though maximizing oil palm yield per hectare is not the main objective.
- Coffee and banana combinations will benefit from the shade, and annual crops such as beans and maize may be added to provide food for home consumption.
- Fruit trees in the crop mixture add supplementary nutrition and income.



A typical homegarden, being a complex agroforestry system, in this case with coffee, banana, yams, oil palm and other fruit and timber trees.

Areas suitable for oil palm are Lake Victoria islands, mainland shore districts and in central Uganda, in the coffee-banana agroecological region, with most common combinations including coffee, banana, coco yams and trees (e.g. *Maesopsis eminii* and *Ficus natalensis*).



Oil palm and other tree species should be planted or spaced far enough apart so as not to completely shade the crops grown in between.

## Multipurpose use of oil palm from homegardens – DR Congo

Oil palm trees are found in the forest and are planted and kept in homegardens. And as a native species, people have learned over many generations how to use every part of the tree for some practical use or value. For example, besides the use of the oil itself from the pressed fruit, trees are a source of palm wine, edible beetle larvae, craft items woven from palm fronds, and home-produced secondary products from palm oil, including soap, body lotion and food for livestock and poultry. In addition, the manufacture and sale of palm oil products significantly improves women's control of household income.

All palm oil is produced artisanally, and 80% is used for local consumption and supporting local livelihoods, with 20% used for manufacturing other products such as soaps, cosmetics, inks, resins and other chemicals for domestic use. Crude palm oil is used with other vegetable oils for cooking, and sometimes purchased by local industries for further processing.

Logs from old palms are sawn and the timber is used for rustic construction, furniture, and public works such as bridges and buildings.

Oil palm is a part of life. Infants, young brides and breastfeeding mothers use skin lotions based on palm oil. Palm wine is a popular drink. Larvae collected from oil palm trees

are in high demand as a food. Palm heart, the core of young stems (locally called macaroni) is very popular. But to produce palm wine and larvae, the tree must be killed, so to meet the growing urban demand, young plants are often harvested completely.

Oil palm shells make up some 10% of the total weight of fresh fruit bunches, and are used as fuel, or with other residues as a feed for livestock, poultry and in fish farming. Palm oil is mixed with extracts from other plants in traditional medicines to treat cramp, blocked sinuses, wet coughs, colds and other ailments such as sinusitis. The bicarbonate from burnt palm nut shells is used when cooking cassava leaves, and also has therapeutic virtues. Palm branches are used for ornamentation and various cultural rites in birth, initiation, marriage and death ceremonies. In fact, oil palm products accompany every rural Congolese person from birth until death.



Artisanal extraction of palm oil in Tshopo province, DR Congo.

*Photo: Patrick Matata/Tropenbos DR Congo.*





# Recommendations



As a long-lived 'tree' that takes 4-5 years to first fruiting, there are benefits from growing annual crops at the outset. Intercrops differ in competitive ability, so it is important to consider this when making decisions on what, when and where to plant if an efficient intercropping system is to be realized. Yield advantages occur when component crops differ in their use of growth resources in such a way that when they are grown in combination, they are better able to complement each other and so make better overall use of resources than when grown separately.

More research is required, but smallholder farmers usually opt for intercropping because it provides food crops or cash crops throughout the year. Many negative impacts following oil palm introduction can be resolved or drastically reduced if oil palm agroforestry or intercropping is encouraged, providing farmers with additional income while safeguarding multiple livelihood options for the benefit of both farmers and oil palm companies. Global experiences supported by local surveys show that intercropping needs to be promoted, requiring action by the Ministry of Agriculture, the donor IFAD, the companies BIDCO and OPUL, and the farmer association KOPGT.

Once oil palm intercropping and agroforestry options for Uganda are developed, based on models presented in this guide, community mobilization and empowerment will be necessary if the policy objective of developing both food and

commercial crops is to be achieved. This should not decrease overall production, and will likely increase production, and smallholder resilience. The ministries and agencies responsible for the oil palm sector must then work to educate farmers on these various options and provide supporting services.

Four specific recommendations for the Ministry of Agriculture, IFAD, BIDCO, OPUL, the National Crops Resources Research Institute of the National Agricultural Research Organisation (NARO) and producer associations.

1. Promote growing of food and cash crops in young plantations in the first four to five years after planting.
2. Increase the extension available to outgrowers and smallholders on oil palm intercropping and suitable agroforestry systems, best practices and crops, and provide planting material and support for marketing.
3. Incentivize the adoption of alternative planting systems and permanent intercropping, that provide more diverse economic and environmental benefits and better meet farmers' needs.
4. Invest in research and establish demonstration plots using double row alley systems, boundary tree planting and other mixed cropping systems.

# Glossary

**Agroforestry:** The collective name for land-use systems and technologies where woody perennials (trees) are deliberately used on the same land management unit as agricultural crops (oil palm) and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economic interactions between the different components (Lundgren and Raintree, 1982).

**Agronomic practices:** These are what farmers incorporate to improve soil quality, enhance water usage, manage crops and improve the environment (FAO, 1984).

**Annual crop:** Plant that complete their life-cycle within 12 months from the date of germination (IBPGR, 1991).

**Competition:** Is an interaction between individuals, brought about by a shared requirement for a resource in limited supply, and leading to a reduction of the performance of at least some of the competing individuals (Begon et al., 1996).

**Complementarity:** Is a general term that is used to describe the positive effects that can result from intercropping (Duchene et al., 2017).

**Intercropping:** Intercropping is the cultivation of two or more crops simultaneously in the same field, and is common in Africa, the Americas and elsewhere (Li et al., 2013).

**Mixed farming:** This is the most basic form in which component crops are totally mixed in the available space, including the growth of two or more crops simultaneously on one plot (Ruthenberg et al., 1980).

**Monocropping:** Monocropping is the agricultural practice of growing a single crop year after year on the same land, in the absence of rotation through other crops (Vandermeer et al., 1998).

**Nucleus plantation:** Is a large farm unit (plantation, large-scale farm) which guarantees a certain minimum provision of raw material for a large-scale processing plant or other downstream aggregation use, while the other part of the raw material is procured from smaller farmers who are linked through “outgrower” (Hall et al., 2017).

**Perennial crop:** Plant species with a life-cycle that characteristically lasts more than two years. The plants may flower annually (IBPGR, 1991).



**Permanent intercropping:** Perennial crops (trees and shrubs) are inter-planted through cash crops during the period of establishment of the main crop. At a later stage the inter-planted crops might be replaced by cover crops (Rothenberg et al, 1980).

**Row-intercropping:** Growing two or more crops simultaneously where one or more crops are planted in regular rows, and crop or other crops may be grown simultaneously in row or randomly with the first crop (Vandermeer, 1992).

**Smallholder farmer:** The term 'smallholders' includes small farmers who own/control the land they farm and those who do not. Often, the term 'outgrower' is used to refer to a smallholder who is in a dependent, managed relationship with an exporter. Smallholder farms are typically less than 5 hectares and very diverse, though they vary considerably across the continent (Eastwood et al., 2009).

**Spacing:** Seed/crop spacing is the distance between seeds/plants in a given row and the distance between rows. It is about the distance between one plant and another. Crop spacing enables us to tell the number of crops planted in a unit area.

**Strip-intercropping:** Growing two or more crops simultaneously in different strips wide enough to permit independent cultivation but narrow enough for the crops to interact ergonomically (Vandermeer, 1992).

**Temporary intercropping:** Uses the practice of sowing a fast-growing crop with a slow-growing crop, so that the fast-growing crop is harvested before the slow-growing crop starts to mature (Ruthenberg et al., 1980).

**Yield:** Production per unit area over a given time. A measure of agricultural production (FAO, 1984).

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## Ecological Trends Alliance

Ecological Trends Alliance is a registered non-governmental organization in Uganda, starting operation in 2011 as a limited guarantee company, and registered with the National bureau for Non-Governmental Organizations in 2016. Our mission is to secure global solutions to biodiversity, development and tourism challenges through providing biologically diverse and proven alternatives Ecological Trends Alliance implements programmes, projects and studies in biodiversity conservation and sustainable development, in partnership with national, multinational and international companies and organizations. This has included environmental, social and economic research, impact assessments, inclusivity studies, forest governance and community engagement, conservation (camera trapping, wildlife telemetry, etc.), human-wildlife conflict management, tourism potential site assessments, restoration of degraded landscapes, enrichment planting and agroforestry, landuse planning, offset valuation and impacts of agrocommodity production. Now in its tenth year, Ecological Trends Alliance continues to grow and expand its partnerships to meet our strategic objectives.

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## Tropenbos International

Tropenbos started in 1986 as a Dutch non-governmental non-profit organization, and in 2017 became a network of independent member organizations in more than ten countries. Our unique value is a focus on smallholders, indigenous peoples, local communities and small and medium-sized entrepreneurs, a central role for knowledge and dialogue to support decision making about forests and trees, and a long-standing relationships of trust with key actors in focus countries. Tropenbos International envisions a future in which forests and trees are used sustainably for the benefit of local people and the global community. By using evidence to make conscious choices and finding the right balance between the needs of all the stakeholders involved, we contribute to sustainable solutions for forested landscapes. We bring knowledge together to address complex questions regarding sustainable management of forests and trees, organizes interactions with all stakeholders, and actively helps to create broad support. Sustainable, inclusive and equitable development is an achievable goal once stakeholders participate in shaping decisions that govern forested landscapes and value chains.

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