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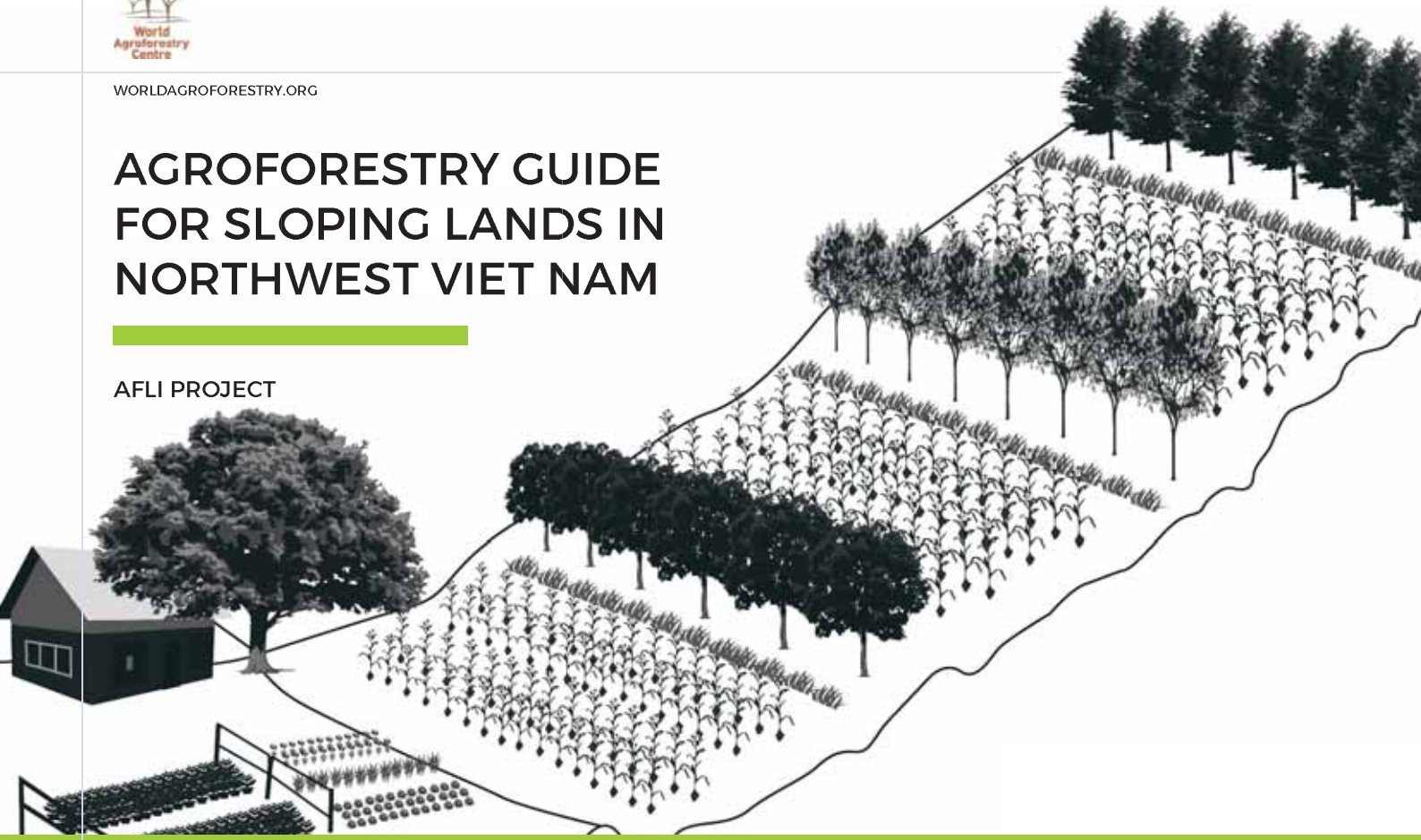
AGROFORESTRY GUIDE FOR SLOPING LANDS IN NORTHWEST VIET NAM

AFLI PROJECT



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AFLI

AGROFORESTRY FOR LIVELIHOODS OF SMALLHOLDER FARMERS IN NORTHWEST VIET NAM

The AFLI project aims to increase the productivity of smallholder farming systems in Northwest Viet Nam, while also conserving the natural resource base. The project introduces trees in mono-cropped landscapes through agroforestry to reduce dependence on annual crops, as well as increase and diversify incomes from tree products. A variety of agroforestry options ensure short- and long-term benefits for farmers, while trees provide ecosystem services such as prevention of soil erosion. Several tree species are currently being tested in agroforestry systems to evaluate their suitability under different agro-ecological conditions across Dien Bien, Yen Bai and Son La provinces in Northwest Viet Nam.

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FOREWORD

In Northwest Viet Nam, rain-fed crop cultivation is dominated by monoculture maize, upland rice, and cassava on sloping lands. The loss of topsoil during the rainy season leads to a reduction in nutrient and crop yield. Farmers have to invest heavily in chemical fertilizers for the maize fields to remain productive. Harsh weather conditions reduce yields, and makes soil and water conservation more difficult. Agroforestry offers an integrated approach that can secure the livelihoods of rural households while curbing land degradation and deforestation.

The 'Agroforestry for Livelihoods of Smallholder Farmers in Northwest Viet Nam' (AFLI) project aims to improve the performance of smallholders farming systems in Northwest Viet Nam through agroforestry by increasing the productivity of associated crop and livestock systems, leading to more diverse, and sustainable production systems and better income from tree products.

This Agroforestry Guide aims to provide users with basic knowledge on agroforestry as an agriculture, and natural resources management strategy. Intended for farmers and local extension workers, the Guide is written in a simple manner and presents basic steps in establishing agroforestry.

I WHAT IS AGROFORESTRY?

Agroforestry is defined as 'a land use system in which woody perennials (trees, shrubs, palms, bamboos) are deliberately used on the same land management unit as agricultural crops (woody or not), animals or both, either in some form of spatial arrangement or temporal sequence' (Lundgren and Raintree, 1982). Nair (1993) further defined agroforestry system with the following characteristics: Agroforestry normally involves two or more species of plants (or plants and animals) at least one of which is a woody perennial; It always has two or more outputs; The cycle of agroforestry systems is always longer than 1 year; It is more complex ecologically and economically than a mono-cropping system; And it presents the interaction between components (positive and/or negative).

The combination of trees and crops is detemined using the principle of optimizing the use of land for agricultural production on a sustainable basis. Agroforestry systems need to be blended and balanced with other technologies in order to enhance productivity, profitability, diversity and ecosystem sustainability.

II TYPES OF AGROFORESTRY

There are various types of agroforestry systems, which may be classified in four main groups:

- **Trees on farm land:** Trees are planted on the farm to provide food, income, soil improvement and shade for animals.

- **Parkland:** Parklands include well-grown, scattered trees on cultivated and recently fallowed land. The trees are scattered far apart and do not compete with associated crops.

- **Alley cropping:** Alley cropping is a system in which strips of annual crops are grown between rows of trees or shrubs or hedgerows that are lined with woody plants, creating distance between crops to minimize competition.

- **Wind breakers and shelter belts:** Planted trees serve a major purpose in controlling wind erosion and providing shelter.

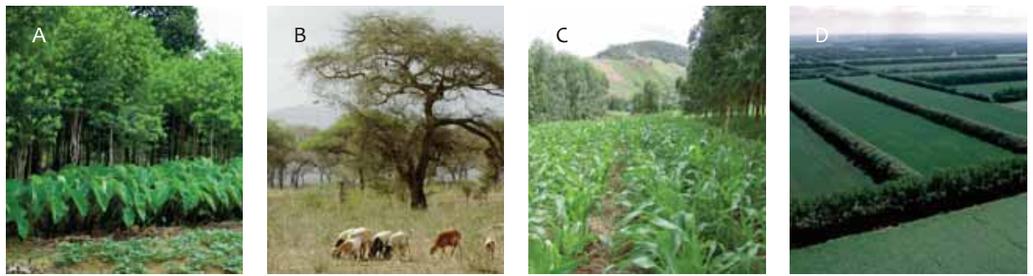

Figure 1: Types of agroforestry (A) Tree on farm land, (B) Park land, (C) Alley cropping and (D) Wind breakers and shelter belts

III FEATURES OF AGROFORESTRY SYSTEM

Agroforestry systems may be classified based on the following criteria *(Xu et al. 2013)***:**

- On **a structural basis:** This refers to the composition of the system and its arrangement of it in space and time. Adding woody species into different niches (different parts of farms and the agricultural landscape) can increase diversity, sustainability and productivity.

- On **a functional basis:** This refers to the role or use of the tree component such as timber, fruit, fodder, medicine. Typically, the inclusion of trees increases the number of products generated by the system, which then acts as a safety net for farmers. Services such as the use of trees as windbreaks and to prevent soil erosion may also be important in addition to tree products.

- On **a socioeconomic basis:** This refers to the purpose of the system with regard to human livelihoods, usually broken down into subsistence, commercial and/or intermediate production systems. Agroforestry may be promoted to meet specific social goals such as poverty alleviation and food security.

- On **an ecological basis**: This refers to the suitability of the agroforestry system for a given environment. Thus, there are different types of agroforestry for tropical, temperate and arid environments that take into account the environmental, ecological and biological conditions of each area.

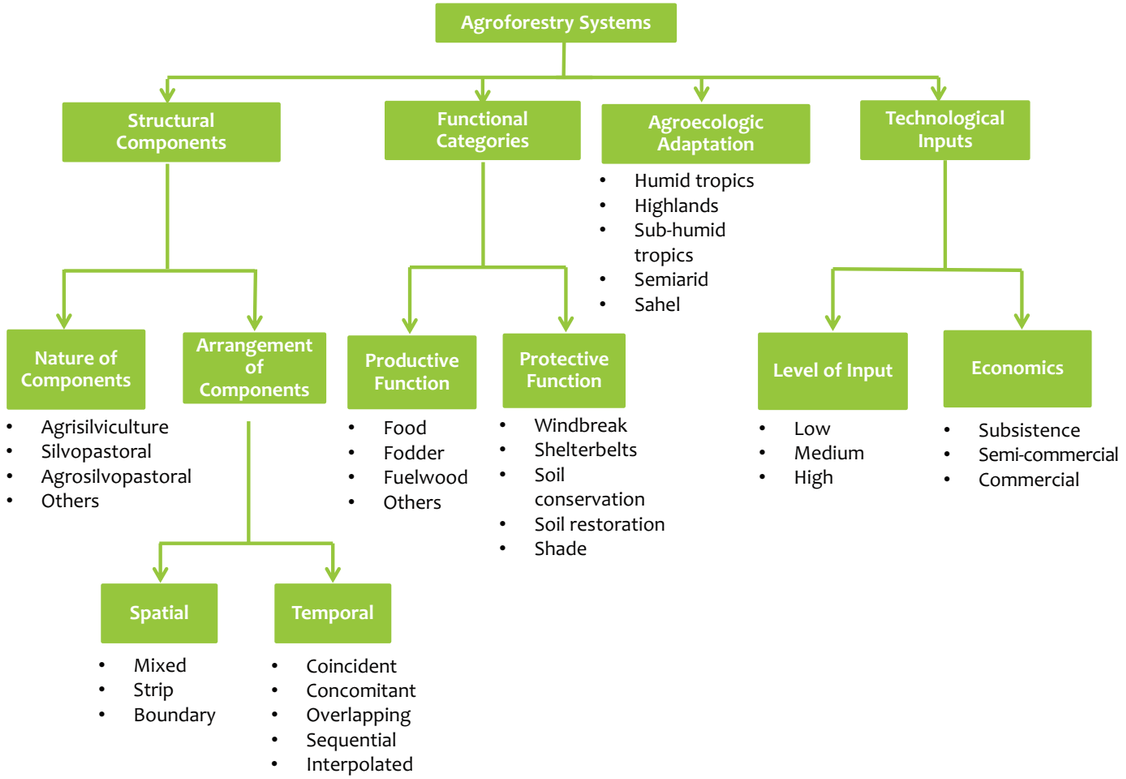

Figure 2: Features of agroforestry (compiled from Xu et al., 2013)

IV WHY AGROFORESTRY?

The rapid expansion of agriculture and widespread shifting cultivation has resulted in degradation of agro-ecosystems and forest destruction and fragmentation. Rain-fed crop cultivation is dominated by mono-cultural maize, upland rice and cassava on sloping lands. The loss of top soil during the rainy season leads to reduction in nutrient and crop yield. Farmers have to invest heavily in chemical fertilizers for the maize field to remain productive. Harsh weather conditions also reduce yields or even lead to crop loss, and make soil and water conservation even more difficult. Current practices in sloping lands threaten environmental sustainability and food security in the Northwest region.

The risk of decrease or loss in crop production is eminent in sloping land. Incorporating trees in mono-cropped landscapes through agroforestry reduces dependence on annual crop production and increases incomes from tree products that can help secure the livelihoods of rural households while curbing land degradation and deforestation.

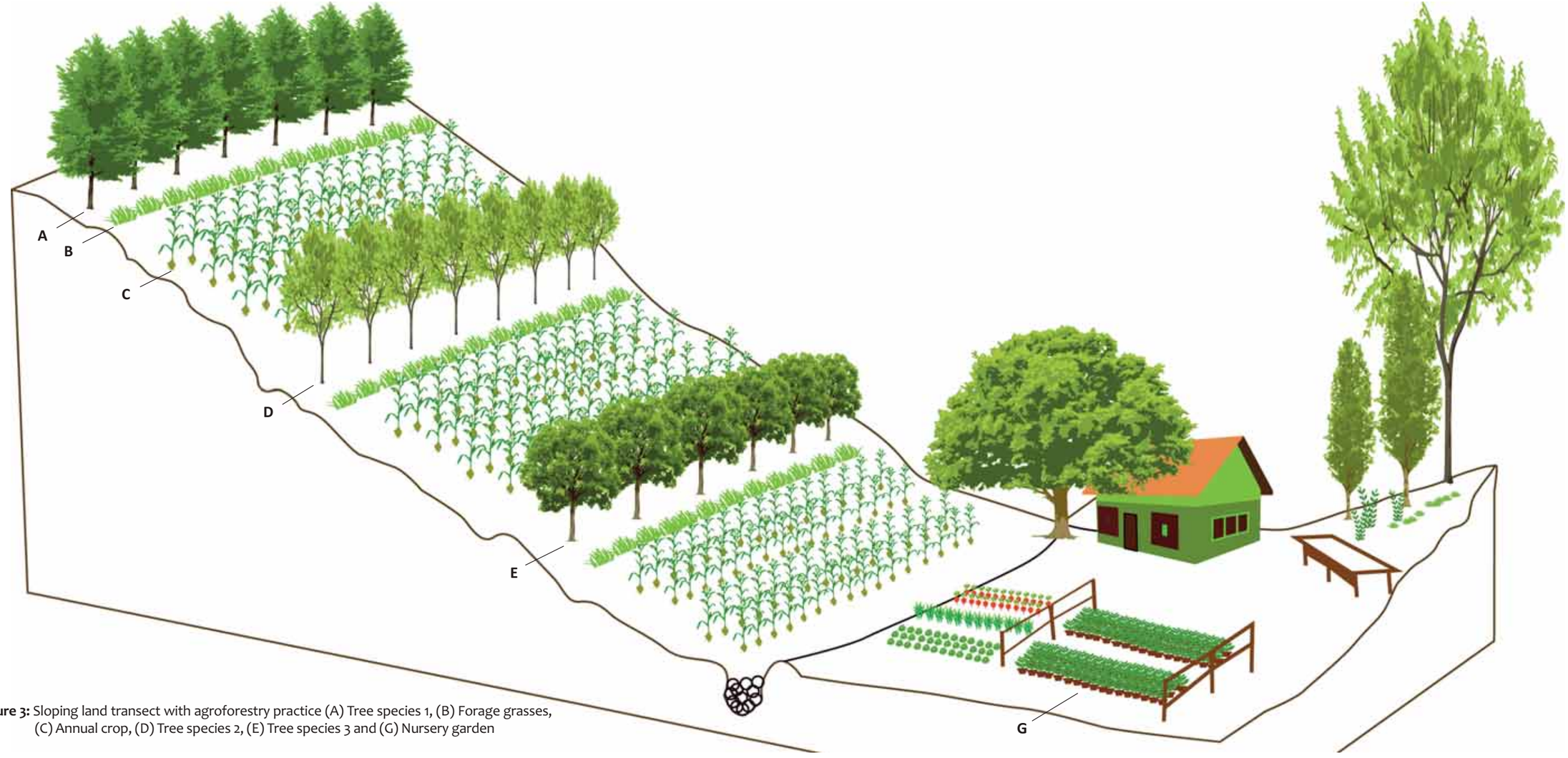

Figure 3: Sloping land transect with agroforestry practice (A) Tree species 1, (B) Forage grasses, (C) Annual crop, (D) Tree species 2, (E) Tree species 3 and (G) Nursery garden

V HOW TO ESTABLISH AGROFORESTRY

Sloping lands are fragile ecosystems susceptible to soil erosion. Up-down cultivation in sloping lands accelerates soil erosion. We therefore recommend the establishment of agroforestry along contour lines.

1. What is a contour line?

A contour line is a line that connects all the points that are equally elevated above a reference level (usually sea level). In a slopping land, runoff will pass perpendicular to the contour lines. If trees and crops are planted in the contour lines, the highest effectiveness of reduction in soil erosion following runoff will occur. The result is soil nutrients staying in place and increase in soil moisture due to an increase in the amount of water infiltrate into the soil.

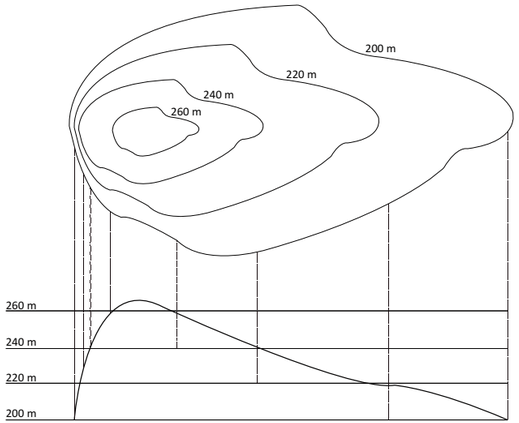

Figure 4: Contour lines of the hill

2. How to lay out contour lines

There are many methods and tools that can be used to lay out contour lines in the field such as A-frame, O-ring or buffalo or cow's back. Here, we introduce a simple and widely used method, the A-frame.

To make an A-frame, prepare three sturdy wooden (or bamboo) poles: two 2-m long and one 1-m long (Figure 5a), string, nails and weights (stone, etc). Nail the two wooden poles at one end, which serves as the legs. Spread the legs at the opposite end. Mark the middle of the two legs 1 m from both ends. Nail a 1-meter wood as crossbar at the one meter mark of the legs. Put a nail where the two legs cross. Tie the string on the nail and extend the string below the crossbar. Tie a weight (stone, etc) 15 cm below the crossbar. To calibrate the A-frame, take it to a sloping field, and stake both ends of the legs. Mark the crossbar where the string hits. Twist the A-frame and mark the crossbar where the string hits. Using a string, measure the two marks and fold. Put the folded string on one of the two marks as the center mark. This center mark is the center of the crossbar, which determines the contour lines.

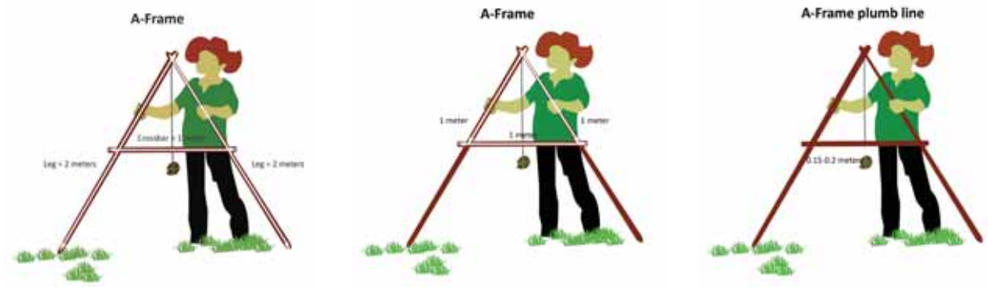

Figure 5a: Making simple A-frame with bamboo poles, string and stone

When using the A-frame, the task is much easier and faster with two people working together. One operates the A-frame while the other marks the located contour lines with stakes. Begin marking contour lines at the middle of the slope of the farm. Let the A-frame stand on the ground. Without moving the rear leg, put the front leg down on the ground, moving this leg until the string hits the center of crossbar. When this happens, it means that the contour line is determined. Mark with a stick the spot where the rear leg stands. Twist the A-frame forward and adjust the front leg until the string hits the center of the crossbar (Figure 5b). Follow this procedure until reaching the entire length of the contour line. After and the contour lines have been located and marked, calibrate the contour line by standing at every 4-6 stakes. Align stakes which are off-contour due to sudden depression caused by gullies or rocks. Prepare the contour lines by plowing until ready for planting.

Figure 5b: Laying out a contour line variation

The other simple and faster way of laying out the contour lines is the use of cow's or buffalo's back. This is simply done by observing the back of the animal when it is walking on the level land looking at the front shoulder and the hips. Start laying out the contour lines in the middle of the hill or farm, which has an average slope across the field. Guide the animal across the slope so that the level of the front shoulder and hips are as if the animal is walking on flat land as shown in Figure 5c. Make another pass 50 cm above or below the first pass. Do a similar procedure for subsequent contour lines spaced at 6-10 m above and below the first contour line. If the soil is well compacted and the animal tends to bend its back, do a shallow plow during the first pass and plow again when the contour lines are already determined.

Figure 5c: Cow or buffalo's method of laying out contour lines

3. How to select the trees to plant in your field

Normally, farmers have different reasons for selecting the tree species to plant on their fields. Almost always, it is to provide for the needs of the family and supply the market.

However, farm conditions such as soil type and its properties, climate and elevation among others are also important considerations, as these parameters affect the growth of trees. Trees that are in demand may not be adapted to local conditions and vice versa. Species native in the area have high potential while exotic trees may need to be tested on a smaller scale before planting in greater number. Also, farmers tend to select tree species with readily available planting materials.

Tree characteristics such as canopy, height and root system are also an important considerations in choosing what trees to plant for a particular agroforestry system. The essence of agroforestry is for the trees and associated components (crops and forages) to complement each other's growth rather than compete for light, water and nutrients. Knowledge about tree characteristics is then matched with farmers' objectives. For example, trees with wider canopies may need to be spaced farther apart to minimize light competition, especially if farmers aim to continuously plant crops in the alley area.

BOX 1 AGROFORESTRY TREE SPECIES SUITABILITY BASED ON ELEVATION IN THE NORTHWEST REGION

In Northwest Viet Nam, two indigenous species, Shantea and Son tra (Docynia Indica) are found in areas above 800 masl. These species play an important role in the livelihoods of ethnic minorities, particularly in Tua Chua, Toa Tinh (Dien Bien) and in Tram Tau (Yen Bai). Plum is also suitable in areas with elevations higher than 800 masl. However, Son tra and Plum can be harvested once a year; therefore, it should be intercropped with crops when the tree canopies are still open, to take full advantage of land resources.

Arabica Coffee is also an important species in the Northwest, since it is considered high value. It performs well in elevations above 300 masl, while macadamia, which is exotic to the area does well from 300 to 1200 masl. These species are compatible when combined in an agroforestry system as coffee needs shade. Annual crops can also be grown in between rows of trees when their canopies are still open.

Longan is suitable in areas below 800 masl. This fruit tree species has a large canopy and fruits can be harvested once a year. If planted in association with annual crops, the system can take full advantage of growth resources. Meanwhile, mangoes are more suitable in less than 300 masl. Teak trees have longer rotations (>15 years in the Northwest) and are best planted in single row in an agroforestry system. Acacia mangium is more suitable in less than 800 masl and is good for nitrogen fixation.

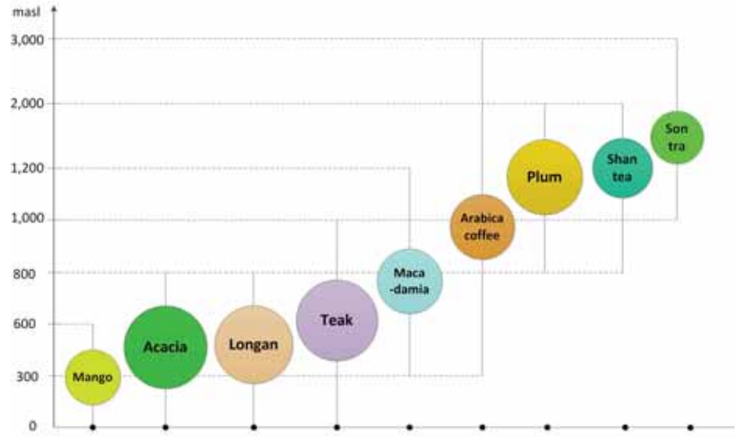

Figure 6: Tree species suitable for different elevations in the Northwest region

4. What happens when there are too many choices of tree species?

When farmers have many choices of tree species, researchers and/or extension workers should assist in decision-making through a species prioritization exercise. Below is an example with 10 farmers in Tuan Giao district, Dien Bien province.

10 farmers proposed six species such as macadamia, longan, plum, pomelo, mango and lichi. Farmers chose macadamia because they hear it could command a good price in the market. The other species were already known to grow well in the area, by farmers. The farmers agreed on a number of criteria in prioritizing tree species such as (i) low investment (in terms of labor involved); (ii) high yield; (iii) pest resistant; (iv) farmers had already seen the trees growing somewhere with similar conditions as their own farms; (v) easy to sell in the local market for a decent price and (vi) easy to manage in terms of available labor. Farmers individually ranked the species from zero to five based on the above criteria, and discussed the individual choices as a group. Then the group reached a consensus to plant plum and litchi, followed by longan, pomelo, mango and macadamia (Table 1). The exercise supported farmers' decision making on what tree species to plant, and even how many trees should they be planting. The exercise also helped farmers define the opportunities and risks associated with their choice.

Table 1: Tree species assessment in Tuan Giao, Dien Bien

Criteria	Tree species					
	Macadamia	Longan	Plum	Pomelo	Mango	Litchi
Low investment	1	4	4	4	4	5
High yield	0	2	3	4	2	3
No/low pests	2	3	4	2	1	4
Suitable to the local condition	4	4	4	4	4	4
Easy to sell	0	4	4	3	4	4
Good price	0	3	3	2	3	2
Easy to manage	4	4	4	4	2	4
Total score	11	24	26	23	20	26

5. What is a suitable agroforestry system for you?

5.1. Intercropping with one tree species

Farmers may prefer to intercrop with one tree species to have more space to continuously plant annual crops or until the tree canopies are closed. This practice is commonly known as simple agroforestry. The distance between rows of trees is decided depending on the farmers' objective as mentioned above.

BOX 2 SINGLE TREE SPECIES WITH SINGLE CROP/FORAGE GRASSES

The components of this agroforestry system are Son tra and forage grasses (Mulato and Guinea). The distance between Son tra trees (Figure 7a) was 4 m (A) and 5 m (B) between rows. Mulato and Guinea grasses were planted 1 m away from the trees. This system is helpful for farmers with at least 15 heads of cattle. Based on this trial, the annual grass yield could reach 35-50 tons (Figure 7b).

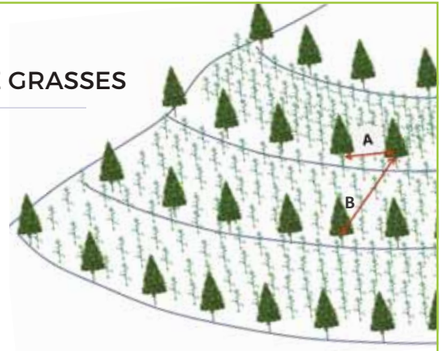

Figure 7a: Distance between tree and crop

Figure 7b: Son tra - Mulato grass trial in Toa Tinh, Dien Bien province

BOX 3 SINGLE TREE SPECIES WITH SINGLE CROP AND FORAGE GRASSES ON CONTOUR LINES

The components of this system are Longan, maize and forage grasses on contour lines (Figure 8a). Depending on the farmers' objective, longan trees can be planted in a single or double row between the alley area. In this trial, longan trees were planted 5 m apart (C - Figure 8a). The distance between two rows of trees (Figure 8a) is 5 m (D), and 15 m between the double rows (E). Maize is planted in an alley area of 15 m. Forage grass (Mulato) was planted 50 cm below the two rows of trees, to control erosion and provide animal feed.

During the first three years of the trial, income was earned primarily from maize and forage grass. The total income in the fourth year was approximately 40 million VND/ha/year. Maize yield was up to 5.8 tons/ha/cropping, which is not significantly different from monoculture practice, while the harvest from Mulato grass was 6-18 tons/ha/year. The system has proven effective in controlling soil erosion. In 2015, soil loss was recorded at 20 tons/ha compared to 34 and 36 tons in monoculture longan and maize, respectively. This is equivalent to saved nutrients: 140 kg for N, 20 kg for P and 120 kg for K (equivalent to 250 USD).

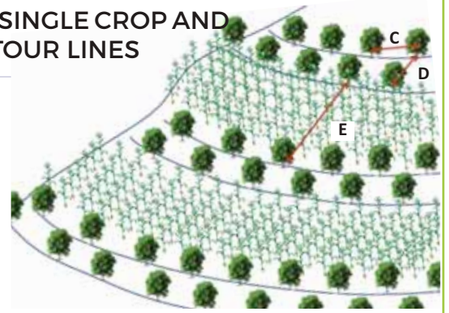

Figure 8a: Distance between tree and crop and forage grasses

Figure 8b: Longan - Maize - Mulato grass trial in Van Chan, Yen Bai province

5.2. Intercropping with two or more trees species

Farmers may likewise, prefer to plant more than one tree species. In this case, we recommend both low and high statured tree species to better manage light competition. High statured species can be timber or fruit trees while low-statured trees can be perennials like coffee. In this system, annual crop production in the alley area could be limited to 3-4 years, or until the tree canopies close.

BOX 4 TWO TREE SPECIES AND SINGLE CROP

Coffee (Arabica) is of interest to farmers in the Northwest. However, the frost in the Northwest sometimes affect the growth of coffee. Tall trees with wide canopies can reduct the risk of frost. In the AFLI project, the Macadamia - coffee - soybeans system was established in June, 2013 in Son La and Dien Bien provinces. Soybean yield was 0.2 tons/ha/year. Coffee was harvested in the third year at 4.1 tons/ha/year. The income in the third year mainly comes from coffee and soybean and was approximately 25 million/ha/year.

In this system, the recommended distance between macadamia trees (Figure 9a) is 7 m (distance F) and 9 m between rows of trees (distance G). For coffee, the distance between trees is 1.4 m (distance H) and 2 m between rows of trees (distance K). Meanwhile, soybeans are planted in spaces between rows of coffee.

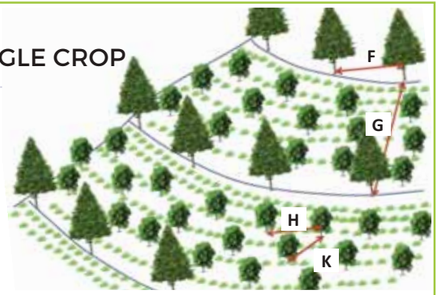

Figure 9a: Distance between two tree species and crop

Figure 9b: Macadamia - Coffee - Soybeans system in Co Noi, Son La province

BOX 5 MULTI-STRATA AGROFORESTRY SYSTEM

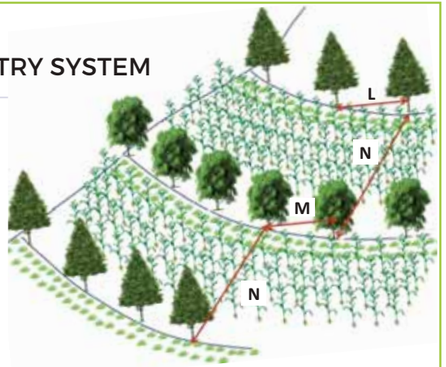

Figure 10a: Distance between tree species with crops and forage grasses

Diversified systems are normally applied in areas with high population density. Farmers living in this area are willing to pay for higher investment (funds and labor) for their farm. It helps to provide both short-term and long-term products, and effectively reduces the risk of low or lost yield during extreme events. In this system, farmers identified different tree species planted along contour lines, e.g. timber trees (teak, acacia), fruit trees (mango, plum). They also added forage grass strips below the tree rows to prevent run off and soil erosion, and to harvest grass biomass. The alley (area between tree rows) is planted with annual crops (maize, cassava), but perrenials are also and option, like coffee.

In Figure 10a, the distance between single rows of trees must be at least 10 m (distance N). 50 cm wide grass strips are established below the tree rows. The alley area is 5m wide, and is planted with annual crops, giving enough space for fruit trees, should farmers decide to grow trees instead of annual crops. The recommended distance between trees in each row depends on the species (distance L and M - Figure 10a). For mango, the recommendation is 4 m; for teak and acacia, 3 m. For other species such as longan, macadamia and Son tra, the recommendation is 5, 7 and 4 m, respectively.

Figure 10b presents a more complex multi-strata system with five components: teak, plum, coffee, soybean and forage grass. Soybeans are planted while the coffee canopy is not yet closed.

Figure 10b: Teak - Plum - Coffee - Soybean - Forage grass system in Co Noi, Son La province

TEAK - PLUM - COFFEE - SOYBEAN - FORAGE GRASS TRIAL (MULTI-STRATA AGROFORESTRY SYSTEM)

Established in May of 2014 to test a multistrata agroforestry system that increases total farm productivity and profitability, while preventing soil erosion.

6. Producing high-quality tree seedlings

Good quality seedling is an important aspect of agroforestry development. The seedling must be guaranteed in quality to ensure good performance.

6.1. Nursery establishment

Nurseries are best located on flat areas close to water resources, to facilitate easy watering of seedlings. Nurseries should also be located near roads for convenient seedling transportation. The size of the area required will vary by the number of seedlings to be produced and the intensity of nursery management. In Northwest Viet Nam, farmer nurseries usually produce 2,000 seedlings annually and are 6x5 m in area; larger nurseries however are usually 10x10 m and can produce 5,000 seedlings annually.

The nursery structures should be built using locally available materials such as bamboo, straw, and poles. This will reduce construction and maintenance costs, making it possible for farmers build nurseries independently. The use of some netting or plastic (to manage sunlight levels and line water catchments) may facilitate nursery management. Depending on the availability of funding, organizational or larger-scale nurseries can be constructed using more permanent materials such as wood, concrete or metal. All nurseries should be fenced to protect them from grazing animals, which are a significant threat to seedlings.

Figure 11: An example of nursery with black net proof and arrangement

Prepare the soil media for seedling using top soil, compost and superphosphate. For timber seedling, the ratio recommended is of 89-10-1 of topsoil, compost and superphosphate, respectively. For fruit seedling, the ratio is 69-30-1, respectively. Pack the mixed materials into the plastic bag, normally 12 cm high by 8 cm wide for timber and 25 cm high by 14 cm wide for fruit seedling.

6.2. Seedling propagation techniques

Seed and scion collection

The criteria for selecting trees from which to collect seeds differ by species. For timber species, the seed should be collected from trees with above average height and diameter and have straight, clear merchantable stems that do not fork and are free of pests and disease. Overall, the tree should be mature, representative of good quality timber and produce ample quantities of seed. For non-timber product species, the criteria is similar. The select tree should be free of pests and disease and representative of the desired qualities of the non-timber product in question. In either case, the seed should be collected from at least thirty different trees (Mulawarman et al .2003). After collection, the seed is processed to remove it from the fruit, pulp, shell, seed coat, etc. Depending on the species, the seed may need to be washed and air dried.

For fruit species, to assure the desired characteristics, propagation is often done by vegetative methods. The criteria specified here are for the selection of scion – the grafting material (buds, stems, etc). Scions are selected from mature trees with good growth, abundant flavorful fruit (demonstrating desired traits), uniform crowns with low branching and free of pests and diseases (Mulawarman et al. 2003).

Propagation by seed

Depending on the species, before sowing in the nursery, seeds may be soaked in VibencC_50_BTN solution, lime solution or warm water. Seeds are then sown in prepared soil pot or in sand beds and later transplanted to the bag. Make sure the water is sufficient to cover the seed and induce germination and growth. One month after germination, fertilizer (12N:5P:10K) can be applied to the seedlings at a rate of 0.2 g per seedling. Fertilizer application can be repeated every month, if fertilizers are available and affordable. The required time for seedling production depends on the species and may vary from 8 to 24 months. The size of mature seedlings varies from 30 to 60 cm in height. Seedlings are prepared for transplanting (hardened) by reducing shade to 25% or 0% one month before transplanting. During the nursery production period, roots that grow out of the pot should be pruned. Seedlings may have to be transplanted to large nursery containers before being transplanted to the field. For detailed discussion regarding seedling production guidelines in Northwest Viet Nam read the related materials in section 6.5.

Vegetative propagation

As mentioned above, fruit tree is normally propagated by vegetative methods. The common methods used in Northwest Viet Nam are grafting and marcotting, depending on the species. The criteria for scion collection is summarized above. Normally, scionsare is collected in March to April or August to September. When grafting stem diameter and root stock diameter are about the same. The scion should be 7-10 cm in length of scion with 2-3 buds. Make one ≥3 cm uniform diagonal cut at the top of the rootstock and a matching cut on the bottom of the scion. Finally, clamp and wrap the scion by grafting tape. Prune wild twigs every 15 days and cut grafting tape when second branch grows. For a detailed discussion on grafting methods, see the related materials in section 6.5.

Fruit species can also be produced by marcotting. First elect a pest- and disease- free 6-8 month old branch on a tree that is strong and high-yielding. Using a sharp, clean knife, make two parallel cuts around the branch and remove a 5 cm width of barkto the cambium layer, allow 5-10 minutes for drying. Form a 10-12 cm ball of soil around the branch wound. Wrap soil ball with plastic and tie it to the branch with string or twist ties. Roots will grow from the branch wound. After 2-3 months the roots will become mature as indicated by becoming dark brown. The branch can be cut using a saw or pruning tool. At the same time, the foliage on the marcot should be reduced by 50% to reduce transpiration. The marcot is planted in a nursery bed contain fertile soil and maintained for 2-3 months before transplanting to the field. Soil appropriate for marcotting is prepared by mixing topsoil and minced straw at a ratio of 50:50, with a moisture content of 70%. Marcottingcan be initiated in the spring between February and March or in the autumn between July and September. For a detailed discussion regarding marcotting, see the related materials in section 6.5.

6.3. Site preparation for transplanting seedlings

To facilitate seedling transplanting, survival and growth, it is necessary to practice adequate site preparation. This is particularly important in grass ecosystems. The objective of site preparation is to reduce weed competition and create conditions where seedlings can thrive. At a minimum, remove all vegetation within 50 cm of the position where the seedlings will be planted. Both above ground and below ground plant biomass (i.e. stems and roots) must be removed. If rows of trees are being established, meter-wide area the length of the rows can be prepared. For individual trees, areas one-meter-diameter are sufficient. Removal of vegetation can be achieved by manual, mechanical, chemical or a combination of means. Cultivating the soil at the planting site (subsection 6.4) will also help seedling establishment and growth. The size and depth of the seed bed depends on the planting site, soil type, tree species and planting system. Site preparation methods used locally should be sufficient. A well-prepared planting sites also encourages weed growth. To minimize weed growth and competition, site preparation should occur immediately before fodder tree establishment.

A few precautions are warranted. The use of burning as a site preparation method is not recommended, unless experienced personnel are present. The removal of 100% of the vegetation from a site is also not advisable. Complete removal of the vegetation is costly and leaves the site vulnerable to soil erosion. Furthermore, some of this vegetation may provide useful products or services. If vegetation is not impeding tree seedling survival or growth, it should not be removed.

6.4. Transplanting and management in the field

Depending on the species, seedlings are ready for field planting when they are 30 to 60 cm tall. In a well-managed nursery, under conditions in Northwest Viet Nam, seedlings should obtain that size in 8 to 24 months, varying by species. Seedlings that exceed this recommended size often have intertwined, damaged root systems due to the restrictive size of nursery containers. Such seedlings may perform poorly in the field.

Seedlings should be planted in pits. To facilitate the planting process, pits are generally prepared a few days to a month before transplanting. Planting pit preparation should be scheduled to fit farmers' time availability. Recommended dimensions are 60, 60 and 30 cm in width, length and depth for fruit and timber tree, respectively. The soil that is removed from the pit should be finely cultivated and returned to the pit. This early preparation allows good infiltration of the first rains of the season and facilitates quick field planting. In Northwest Viet Nam, transplanting seedlings to the field should coincide with the beginning of the rainy season (from April to May) after 2-3 heavy raining events. If available and affordable, the use of organic and chemical fertilizers are recommended. Standard fertilizer recommendations are 10-15 kgs compost and 1-2 kgs NPK (5: 10: 3) per tree for fruit tree; and 1-2 kgs of compost and 0.1-0.5 kgs of NPK per tree for timber species.

Planting pits are usually prepared in the dry season, about one month before the onset of rains. Recommended dimensions are 60, 60 and 30 cm in width, length and depth for fruit and timber trees, respectively.

Spacing between seedlings depends on the species, planting design and management strategy, as described in section 5. Regardless of the spacing, young seedling are vulnerable to competition for moisture, sunlight and soil nutrients. They should be weeded regularly until they achieve dominance over grass and other competing vegetation. All vegetation competing with the seedlings should be removed. Two weeding times in the first year are usually enough. If competition is severe weeding may be necessary on a monthly basis. Under conditions of intercropping with annual crops, weeding will be more frequent and benefit both tree and annual crop growth.

After planting in the field, keep at least 1 m distance from the tree base when planting maize or cassava, or 50 cm when intercrop with soybeans. Cover the tree base with residual material (litter, etc) to keep moisture. After 2 years, the pruning technique should be applied to promote the development and fruit yield.

Seedlings should be planted in the middle of the pit with the top of their soil mass level with the soil surface. Always remove the nursery containers before planting seedlings.

6.5. Reading materials

For propagation of species tree species, we recommend the following reference materials:

1. Sontra grafting technique
2. Macadamia grafting technique
3. Coffee propagation technique
4. Lemon marcotting technique
5. Plum marcotting technique
6. Longan propagation and grafting technique
7. Mango propagation and grafting technique
8. Manglietia propagation technique

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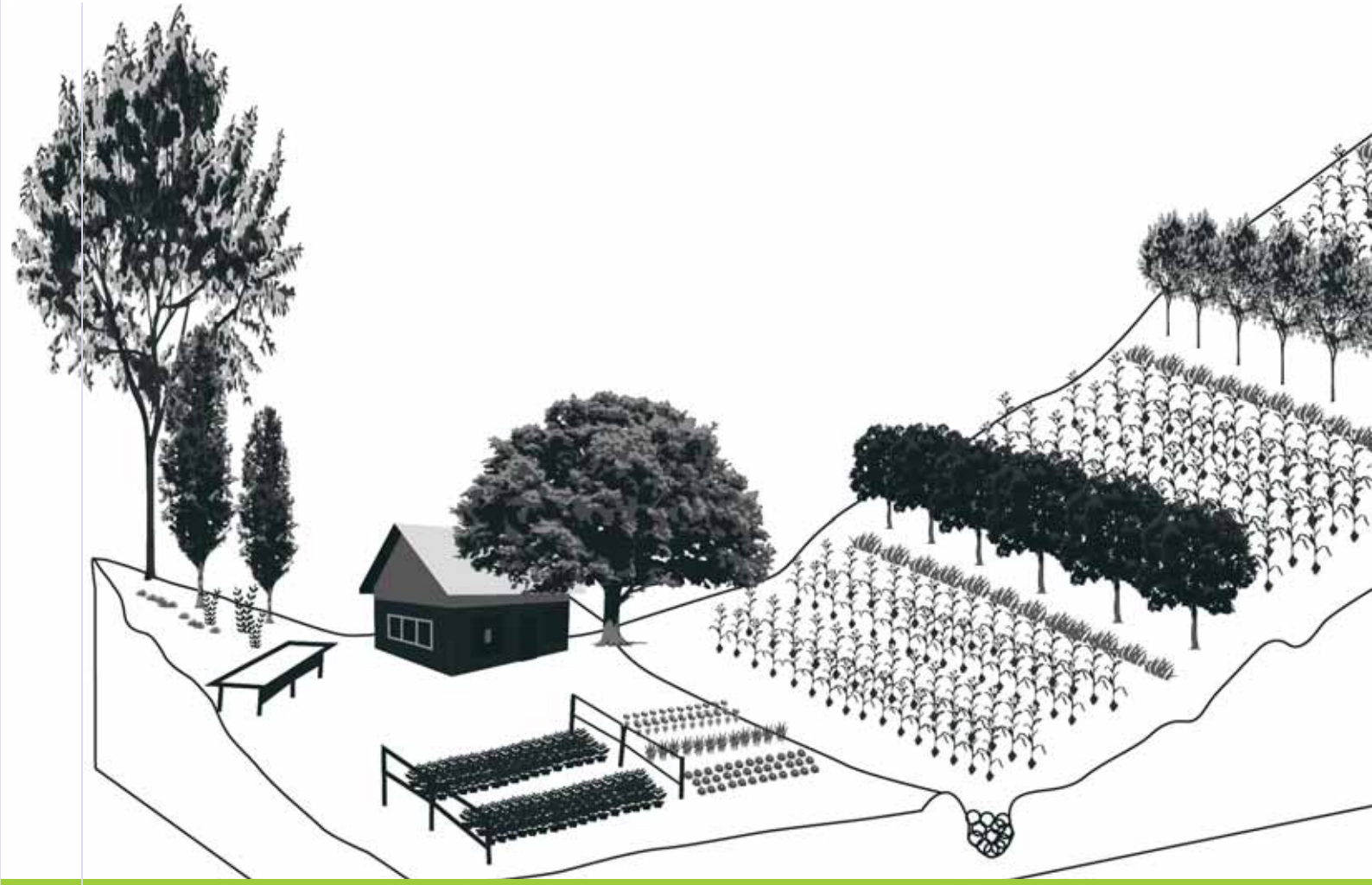

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