A review of the status of agroforestry in Vietnam¹

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1. Introduction to Vietnam

- **Diversity in ecological, climatic, topographical and land features**

Vietnam is located in the Indochinese peninsula, borders China to the north, Laos to the northwest, Cambodia to the southwest and Southeast Asia Sea to the east. The country’s total area is over 330,000 km², of which 3/4 are mountains and hilly lands. Spanning over 15° parallel, from 8°30´N to 23°22´N, Vietnam has highly diverse topographical and climatic features. In general, the country has a tropical monsoon climate, with the annual average temperature of c.23°C, the sunshine time of around 2,300 h/year, the rainfall ranging between 1500-2000 mm/year, solar radiation varying among 100 – 130 Kcal/cm²/year and humidity between 75-90%. However these figures vary greatly from regions to regions and depend much on both the parallel and altitude.

*Figure 1: Ecological regions of Vietnam inland territory*

1. Northeast
2. Northwest
3. Red River Delta
4. North Central Coast
5. South Central Coast
6. Central Highlands
7. Southeast
8. Mekong River Delta

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Administratively the country’s inland area is divided into 59 provinces and 5 cities under the Central Government, but ecologically its inlands can be divided into 8 different regions: Northeast, Northwest, Red River Delta, North Central Coast, South Central Coast, Central Highlands, Southeast and Mekong River Delta (Figure 1). Each of these regions is characterized with specific natural conditions and cultural conditions.

Both North East and North West regions are characterized with complicated topography created by high and rugged mountains with the country's highest peak of Fan Si Pan of 3,142 meters. Over 85% of the land areas in these regions are sloping, of which 62% are with slope of over 25°, 16% with slopes of 15 – 25°. The climate is subtropical with 4 distinct seasons (spring, summer, autumn and winter). In the higher mountainous areas of these regions (Dien Bien, Lao Cai, Yen Bai, Son La, Ha Giang, Bac Kan, Lai Chau, Son La, Cao Bang, Tuyen Quang and part of Hoa Binh provinces), the winter can be very cold, and the climate is suitable for both temperate and subtropical plants (fruits, vegetables, flowers, timbers). In these regions, on hilly sides annual food crops (maize, cassava, upland rice) are produced while in flat lands scattered in valleys or small plains wet-rice are cultivated intensively. There are also large land areas allocated for planting forests where different timber species are produced.

The Red River delta is with subtropical monsoon climate with rather cold and dry winter. The entire delta region is less than three meters, and much of it one meter or less, above the sea level. The land here is fertile with much alluvial deposits brought by various rivers over a period of millennia, and is mainly planted to double-crop of wet-rice. Upland field crops are produced in the 3rd cropping season (in winter, after harvesting of the 2nd rice crop) or in gardens or in warps along rivers. Fruits, mostly subtropical and others (citrus, longan, litchi, banana, papaya, guava...) are planted mainly in home gardens.

The Annamite Range (Truong Son) originates in the Tibetan and Yunnan regions of southwest China, runs North-South along Vietnam's border with Laos and Cambodia. This makes the climatic, soil and topographical features of the North Central Coast specific with very dry and hot summer with foehn wins often blowing through. Both tropical and subtropical plants can be produced in this region; however the drought problem is really problematic. There is a long and big coastal area where crop production faces problems of winds, sands and saline pollution. There are also fertile plains suitable for intensive production of wet rice, vegetables, fruits and tuber/root crops. In the upland and highland areas upland crops, fruits and forest trees are produced.

The South Central Coast is almost hot all the year around, with 2 clearly distinguished seasons, dry and wet, which however do not coincide with the dry and wet seasons in other regions of the country. While in both South and North the summer (or the hot season) is wet,
in the Central part summer is very dry. The costal areas face great problems of drought in the dry season and severe flood problems in the wet season. Wet rice, upland crops, fruits, industrial trees and forest plants of different kinds are produced at small scale.

The Central Highlands (Tay Nguyen) is with rugged mountains, extensive forests, and rich soils. Comprising 5 relatively flat plateaus of basalt soil spreading over the provinces of Dak Lak, Gia Lai, and Kon Tom, the highlands account for around 16% of the country's arable land and 22% of its total forested land. The climate here is typically monsoon tropical with 2 distinct seasons: dry and wet. Farming households in these regions are larger-scale compared to those in the above mentioned regions. Industrial trees (rubber, coffee, cotton, pepper, sugarcane) are mainly produced here. Natural forests still exist with rather good quality.

The Southeast region is on average at 100 – 200 m above the sea level and with tropical monsoon climate. Main crops are industrial perennials and annuals (rubber, cacao, pepper, cashew, coconut, sugarcane, soybean, peanut...). There are also orchards with large scale of different tropical fruits. There are also large land areas for planting forests.

The Mekong delta is a low-level plain, less than three meters above the sea level on the average, with many areas lower than 1 m. There are a maze of canals and rivers criss-crossing through. With about 10,000 km² of rice production area, the delta is one of the major rice-growing regions of the world. The southern tip, known as the Ca Mau Peninsula, or Mui Bai Bung, is covered by dense jungle and mangrove swamps. There are also large areas which are often flooded (for many months or many days in a month) where melaleuca is widely growing. The region also has a typical tropical climate. Farming households in these regions are also larger-scale compared to those in the northern and central part. Main products from this region are rice, aquaculture, and tropical fruits. Commercial orchards in this region are with the largest scale compared to all other regions in the country.

Agriculture, including crop production, agro-forestry, forestry, animal husbandry and aquaculture, according to the Ministry of Agriculture and Rural Development of Vietnam (MARD), has been a mainstay of the economy (MARD, 2009).

• Population, ethnicity and farming cultures

The population of Vietnam is currently over 90 mil., and is predicted to reach over 100 mil. in 2015 and 104 mil. people in 2050 (Nguyen Van Tuan, 2013). Population of Vietnam comprises people from 54 ethnic groups. Viet people, also called Kinh, form the largest group representing over 80% of the whole nation’s population. Kinh, Hoa (ethnic Chinese) and Khmer Krom people reside mainly in the country’s alluvial deltas and coastal plains. Other 51 ethnic minorities live mostly in mid- and high- lands. Each of these 54 ethnicities has distinct culture and language, making Vietnam highly diverse in culture and indigenous
knowledge.

The country had 450,300 households that suffered from food shortage and the poor household ratio around 11.3-11.5% in 2013 (World Bank, 2013). Poverty is more concentrated in rural areas, where 18% of the population remains poor. Among the poor rural areas of the country, the north-western mountain region has the highest poverty incidence, at 28.55% (MOLISA, 2013). Poverty also remains substantially higher among ethnic minorities (50%) than those of the majority groups (8.5 %). Among the ethnic minority population, food insecurity and hunger are widespread, with nearly 30 percent considered “food poor”.

Thus, Vietnam in highly diverse in terms of ecological, climatic, topographical, land, ethnicity and cultural conditions. In general, farming households in the central and northern regions are with small scale, crops and trees are produced in small plots with area often ranging from some tens to some hundreds of meters square. Further to the south, the scale of households are bigger, plots can be as big as some hectares to some tens of hectares.

In the high mountainous areas: upland annual crops (maize, cassava mainly) and trees (forests, fruits and industrials) are produced in slopping lands, and wet rice in terraces and flat lands scattered in valleys or in small plains. There are also large land areas allocated for planted forests or for forest regeneration. Fruits, subtropical and temperate, are produced in home gardens or slopes near to people houses.

In the midland areas: mostly upland crops (cassava, maize, legumes) and industrial trees (coffee, tea, cashew, pepper, sugarcane...) are produced in plateaus or slopping lands, while rice in plain lands. Planting forests are aimed at the tops of the hills for water resources and soil protection. Fruits are produced in home gardens or field/slopes near people houses.

In the deltas: rice is intensively produced in 2 or 3 cropping seasons. Upland field crops are produced in the 3rd cropping season (after harvesting of the 2nd rice crop) or in gardens or in warps along rivers. Fruits, mostly subtropical and others (citrus, longan, litchi, banana, papaya, guava...) are planted mainly in home gardens. Nowadays, increasing rice land areas are planted to upland crops or fruits due to their higher economic benefits compared to rice. Big orchards and vegetable farms have been formed.

In the costal areas and low-lands frequently flooded with saline water: mangrove or melaleuca are popularly growing and aquaculture or rice production are integrated.
Picture 13: Typical farm landscapes in mountainous regions (a & b), small plains in midland regions (c), Central Highlands (d), north and central costal plain areas (e) main deltas (f), often flooded areas in the southwest (g), and mangrove forests.

3 Picture sources: Pham Thi Sen, NOMAFSI, and the following websites:
http://www.google.com.vn/search?q=lang+que+mien+bien
• **Climate change impacts and the needs for transition in agriculture and agro-forestry**

Vietnam is among the countries most vulnerable to climate change (IPCC, 2007). According to MONRE (2011), during the past 50 years the sea level rose about 20 cm; and the Mekong Delta is one of the world’s most vulnerable deltas to the sea level rise. Also, as predicted in the climate change scenarios (MONRE, 2011), by the end of this century the sea level in Vietnam can rise 75 cm - 1 m compared to the 1980-1999 period, and then, about 40% of the Mekong Delta area, 11% of the Red River Delta and 3% of the coastal provinces will be inundated (over 20% of Ho Chi Minh City will be flooded); about 10 - 12% of Vietnam’s total population will be directly impacted and the country will lose around 10% of GDP. Impacts vary widely depending on crops and agroecological regions. The predicted impacts of climate change on crop yields are summarized in Table 1 (World banks, 2010).

**Table 1: Potential impacts of climate change on crop yields in Vietnam**

<table>
<thead>
<tr>
<th>Agroecological regions</th>
<th>Potential impacts of climate change without adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>North-West</td>
<td>Rice yield declines by 11.1-28.2%; yields of other crops decline by 5.9-23.5%</td>
</tr>
<tr>
<td>North-East</td>
<td>Rice yield declines by 4.4-39.%; yields of other crops decline by 2.7-38.3%</td>
</tr>
<tr>
<td>Red River Delta</td>
<td>Rice yield declines by 7.2-32.%; yields of other crops decline by 4.1-32.9%</td>
</tr>
<tr>
<td>North-Central Coast</td>
<td>Rice yield declines by 7.2-32.6%; yields of other crops decline by 4.1-32.9%</td>
</tr>
<tr>
<td>South-Central Coast</td>
<td>Rice yield declines by 8.4-27.0%; yields of other crops decline by 4.0-20.9%</td>
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<tr>
<td>Central Highland</td>
<td>Rice yield declines by 11.1-42.0%; yields of other crops decline by 7.5-45.8%</td>
</tr>
<tr>
<td>South-East</td>
<td>Rice yield increase by 4.3-8.8%; yields of other crops decline by 3.0-22.7%</td>
</tr>
<tr>
<td>Mekong River Delta</td>
<td>Rice yield declines by 6.3-12.0%; yields of other crops decline by 3.4-26.5%</td>
</tr>
</tbody>
</table>

2. **Agroforestry systems in practice**

Although still unfamiliar with the term “agroforestry”, long ago, people of Vietnam already practice agroforestry and have developed systems suitable for their local climate and soil conditions while meeting their household use purpose. Many of the traditional systems are now still in practice. On the other hand, along with development of agriculture and forestry sectors and to meet increasing and diverse needs for economic development, environmental
and natural resources protection, and adaptation to and mitigation of climate change, new systems have been developed. The most popular systems in practices can be grouped in the following types:

(1) **Traditional ‘mixed’ home gardens** (fruit trees + timbers + annual crops + medicinal plants): In homesteads, varying much in size (often from some hundreds to some thousands square meters), plants of different species and types are grown in such a way that, solar, land and water resources are most effectively and intensively used. Traditionally, mixed home gardens are practiced by almost all households in the plains and also by many in the highland regions for timbers, foods, feeds, medicinal herbs, firewoods for household use. Nowadays, mixed gardens are practiced, in both homesteads and also in other land areas, in all the villages over the country, often with larger scale but reduced genetic diversity, especially when the commercial purpose is targeted for (Pham Thi Sen at al., 2008; Nguyen Huu La, 2014). The scale is often bigger in the Central Highlands, Southeast and Mekong delta compared to the northern and central regions.

*Picture 4: Mixed gardens with different layouts in Hoa Binh province*

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4 Photo taken by Pham Thi Sen
Normally, in a mixed garden the following plants are produced:

- Trees: timbers (mela, eucalyptus, conifers...), bamboos and fruits of different kinds depending on the climate and soil condition and also on the household preference and use purpose;
- Annual food crops: maize, legumes, millets, root and tubers, spices. Types and varieties depend on local climate conditions and on household preference and needs;
- Medicinal plants: herbs, such as *Plectranthus amboinicus*, *Ocimum tenuiflorum*, *Boehmeria nivea*, *Artemisia vulgaris* ....
- Ornamentals and honey bees may also be included

(2) **VAC systems** (fruits + timbers + annuals + aquaculture + livestock): VAC is the abbreviation of the Vietnamese phrase Vươn-Ao-Chuông (garden-pond-cage). VAC stands for the production systems which comprise three production components: gardening (agricultural and forest plants), aquaculture and animal husbandry. As mentioned by Ngo The Dan (2008), in a VAC system a number of crops and animals co-exist in rational and close interactions with one another and with surrounding environment under the owner’s production practices (Diagram 1).

![Diagram 1a: Interactions between 3 components in a VAC system](image)

**Diagram 1b: Layout of a typical traditional VAC system**

VAC has also been practiced long ago in all the country sides, but only since 1960s inputs have been spent for research and development of these integrated systems (Ngo The Dan, 2008; Nguyen Thi Hoa and Catacutan, 2013). The design of a traditional VAC system is illustrated in Diagram 3b. Each VAC system effectively and reasonably use all the available land, air, water and solar energy resources and, in turn generate foods and economic profits.

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5 By Ngo The Dan (2008)
for their stewards. Within a VAC system energy and waste are effectively recycled. Often, secondary products and waste are recycled into biogas, fertilizers and other useful products (Ngo The Dan, 2008). These systems, thus, are also environmentally sound and climate-resilient.

Main components and elements of VAC:

- Gardening (V component, Vươn in Vietnamese): This component is somehow similar to the mixed garden systems as already described above. Various trees and annuals are cultivated in multilayers and in such a way that all can absorb enough solar energy and nutrition elements to express good growth and generate high productivity. The most common crop production patterns in a VAC system include (i) in surrounding areas of the garden/s are timbers, bamboos, rattans and creepers; (ii) in main area of the garden/s are fruits or some other main crops produced by the owner; and (iii) in corners and beneath trees are annual crops (vegetables, legumes, spices and medicinal herbs).

- Aquaculture (A component, Ao in Vietnamese): In each VAC system one or few ponds are created either in the centre or close to one edge of the garden for: (i)

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6 Photos taken by Pham Thi Sen
aquaculture (fishes, shrimps, tortoises, amphibians); (ii) water reservoir; and (iii) crop cultivation (taro, duckweed, luffa etc.).

- Animal husbandry (C component, Chuông in Vietnamese): Buffalos, cows, pigs, chickens, ducks, rabbits etc. are frequently reared, depending on the concrete conditions of climate, and also on household capacity, use purpose and preference. Honey bees can also be included. Pen/cages are built in places suitable for energy and nutrient recycling within the system.

Traditionally, VAC has been an integral component and feature of household production, rural self-sufficient economy, and the country culture, beauty and landscape. Nowadays, VAC exit in all villages all over the country; for many households VAC production has been developed and intensified for commercial purpose. Since 1960s many stakeholders are having role in the process of development and intensification of VAC, in particular the VACVINA (Vietnam Association of Gardeners), national agricultural extension network, research institutions, local authorities and traders (Pham Thi Sen at al., 2008).

(3) **VACR systems** (forest trees + fruits + annuals + aquaculture + animal husbandry): VACR is the abbreviation of the Vietnamese phrase Vườn-Ao-Chuông-Rừng (garden-pond-cage-forest). Thus, VACR systems are VAC with an additional component, R-forest. VACR are more popular in the midland and highland regions (Ngo The Dan, 2008). A VACR system can be located far or near to the people houses, and often larger in area compared to VAC, for commercial purpose. Three types of VACR (Agrosiviculture, Agrosivipastoral, and Sivipastoral) are existing. The typical design of an agrosivipastoral system is illustrated in Diagram 2 (Le Trong Cuc, 2011).

![Diagram 2: Layout of a typical VACR](image)

7 Adapted from Le Trong Cuc (2011)
Components of a VACR system:

- Forest (R component, Rừng in Vietnamese): often on the top of the hill, can be regenerated forests of planted forests, and can include forest trees alone, or forest trees accompanied by agricultural or medicinal plants. Most trees used in planting forests are acacia (both hybrids and non-hybrids), pines, casuarina, rubber, cinnamon, bamboos, eucalyptus... Accompanied plants often are medicinal and some annual crops (mainly maize, cassava and beans), and rarely are fruits (banana, annona, durian...) and industrial perennials (tea, coffee...), depending on climate and soil conditions and also on the market divers and households’ use purpose.

- Garden, pond and cage components: are similar as in the VAC systems as described above.

- In some cases, paddy rice fields are also included as part of food production.

(4) **Systems of mangrove forest and aquaculture** (forest trees + fishes/shrimps): There are some 447,000 ha of saline-flooded area along the coastal line in Vietnam where these systems are practiced. For example, in Ca Mau province alone there are around 103,000 ha, and in Soc Trang province about 5,000 ha occupied by these systems. The design and the area of this kind of systems can be largely variable between households and locations (Nguyen Huu La, 2014; Nguyen Xuan Bach, 2011). Often, canals are made around plots of mangrove forests for shrimps or fishes raising (Picture 4).

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8 Photos taken by Pham Thi Sen
(5) Systems of melaleuca with crops and aquaculture (melaleuca + rice + fishes/shrimps + fruits): These systems are practiced mainly in the Mekong delta where there are large land areas which are often flooded (in provinces of Ca Mau, Dong Thap Muoi and Kien Giang). The design can be different between communities and between households. In general, the systems include: (i) canals for raising fishes or shrimps, (i) rice plots, (iii) rice crop and melaleuca trees in mixed plots, and (iii) melaleuca forest/s (Diagram 3).

![Diagram 3: A typical layout of a melaleuca with crops and aquaculture system](https://vi.wikipedia.org)

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9 Source: http://camau.gov.vn

10 Adapted from Nguyen Viet Khoa at al. (2006)

11 Source: https://vi.wikipedia.org
(6) **Systems of forest with upland crop fields and gardens, with or withouts livestock**  
(forest trees + upland field crops + horticulture crops + livestock): These systems are practiced mainly in the northeast, northwest, and central uplands by households with larger land areas (some hectares) in one side of a hill, or in the entire hill. The designs of these systems are highly diverse, and so are their trees and crops, depending on the local climate, soil and topographical features and also on the household use purpose and preference.

- Forest is on the top of the hill, and can be planted or regenerated forests. Planted trees are mainly pines, acacia, cinnamon, illicium, vernicia, magnolia, docynia, bamboos etc. Sometimes, timbers can also be planted along the hill sides or along the “paths” separating lands of different households (Nguyen Van Khoa et al., 2006).

- Upland fields, can be with out without terraces, are for food production. Terraces are for wet (rainfed mostly) rice. The areas without terraces are for different upland food crops (mainly maize, upland rice and cassava). Crops can be mono-cultivated or in accompanied by different intercrops (legumes, pumpkins, vegetables, fruits). Different practices (live fences, rock fences, grass fences) may also be applied for preventing soil erosion.

- Gardens, often with small areas, can be next to the people houses or far from the people house, include diverse crops for household use or for commercialisation (tea, legumes, vegetables, species, banana and other fruits), depending on the climate and soil conditions.

*Picture 6: Some systems of forest with upland crop fields, gardens and livestock in Lao Cai province*

12 Photos taken by Pham Thi Sen
Often, animal (chicken, pigs and sometimes cattle) are raised underneath of trees in gardens or in forests. As most of households in the uplands do not have big enough land area in one hill side, these systems are not so frequently practiced as compared to the above mentioned systems.

(7) **Systems of intercropping of crops into regenerated forest** (regenerated forest + crops): These systems are practiced in mid- and up-lands, in the northern and central Vietnam only. As most regenerated forest areas are with low density of trees, farmers may intercrop different plants for additional income. Intercrops can be medicinal plants, fruits, industrial perennials and annual crops:
- Medicinal plants: *Morinda officinalis* (ba kich), *Codolopsis sp* (đằng sâm), *Amomum* (sa nhân), ginger...
- Fruits: mainly banana, peaches, pineapple
- Food crops: yam, taro, maize, cassava

The purpose of intercropping is to prevent soil erosion and also to generate an additional income for households.

![Picture 7: Ammomum and pine apple in forest](http://www.tintucnongnghiep.com)

(8) **Systems of intercropping of perennials into planted forests** (timbers + perennial crops): These systems are practiced in the hill sides, mainly in the northeast, northwest and central uplands. Most often, planted forests are acacia (hybrid, or *Acasia mangium* or *Acasia auriculiformis*), eucalyptus, cinnamon, illicium, magnolia, rubber and bamboos. Perennial crops mainly are fruits (citrus, banana, mango, litchi, longan), industrial trees (tea, coffee) and medicinal plants (*Morinda officinalis*, *Codolopsis sp*). The design of the systems can very much, i.e. timbers and fruits can be in a “mixture” with different

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13 [http://www.tintucnongnghiep.com](http://www.tintucnongnghiep.com)
densities and layouts with rows or without rows. Sometimes, annual food crops, such as legumes, upland rice, cassava, sweet potato, maize etc. are also intercropped in the interrows of trees during the first 1-3 years of the systems establishment. The purpose of intercropping of annuals into the systems is to prevent soil erosion and also to generate an additional income for the households (Nguyen Huu La, 2014).

![Image of tea intercropped in planted rubber forest accompanied by upland rice](left) and ![Image of Arabica coffee intercropped in planted forest](left) in the northwest region

(9) **Systems of intercropping of annuals in planted forests (taungya systems)** (timbers + annuals): These systems are practiced in hill sides, mainly in the northeast, northwest and central regions. Most often, planted forests are acacia (hybrid, *Acasia mangium* or *Acasia auriculiformis*), eucalyptus, cinnamon, illicium, magnolia, conifers, melia and rubber. Most popular annual crops are cassava, canna, and maize. Less often, other crops like legumes (soybean, black bean, mung bean), ginger, taro and upland rice are also cultivated. Often, trees are planted and managed as usual (i.e. like when they are planted without intercrops). In difference to all the above mentioned systems, in these systems the ‘agroforestry feature’ or intercropping is practiced only during the first 2-3 years of the forest establishment, when timbers are still small. When trees are big enough and their canopies cover most of the ground surface intercropping is no longer suitable. The purpose of intercropping is to prevent soil erosion and also to generate an additional income for households.

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15 Source: Nguyen Huu La (2014)  
16 Photo taken by Pham Thi Sen
Systems of integrating livestock into planted or regenerated forests (livestock’s + forest): Traditionally, farmers raise chicken, pigs, cows, buffalos, deer, goats etc. underneath of trees in forests, both planted and regenerated. Less often, nowadays these systems are still practiced by farmers in the uplands, more often in the northeast, northwest and central regions (http7; http8). As wildly growing grasses underneath of trees are not enough for cattle, farmers may also grow different grasses (panicum, ruzi, guatamela, paspalum...) underneath of trees or along edges of forests. They may built cages or without building cages for animals. Honey bees may also be included.

Picture 5: A system of intercropping taro (right)\textsuperscript{17} and cassava (left)\textsuperscript{18} in planted forest in the northern mountainous region

Picture 10: Raising cattle\textsuperscript{19} and chicken\textsuperscript{20} in forests

\textsuperscript{17} Source: Nguyen Huu La (2014)
\textsuperscript{18} Photo taken by Pham Thi Sen
\textsuperscript{19} http://nongthonmoihatinh.vn
\textsuperscript{20} http://www.thainguyen.gov.vn
(11) **Systems of intercropping fodder grasses into forests** (fodders + forest): With the aim to improve quality feed availability for cattle while reducing soil erosion, different fodder species (guatemala, guinea, vetiver, paspalum, piscanthus, VA06, pulato, ruzi...) are intercropped in forests or orchards. Grasses can be planted in strips or hedgerows along contours, or just intercropped in inter-rows of trees. Forests can be planted (acacia, rubber ...) or regenerated (bamboos or mixed forests). Grasses are harvested for feeding castles as fresh feeds or after processing (http 5; http 6).

![Picture 7: Intercropping grasses in rubber plantation in the NMR and in coffee plantation in Dak Nong](http://m.baodaknong.org.vn)

(12) **Systems of intercropping of annuals into orchards or industrial perennials** (Fruit/industrial perennials + annuals): These systems are quit popular in all regions of Vietnam. However, both fruit trees and industrial perennials are not considered forest trees in Vietnam, and therefore often, these systems are not considered agroforestry. Fruits or industrial trees of many kinds (jackfruits, mango, oranges, pomelo, cashew, coffee, tea, coconut, annona, banana, litchi, longan, macademia...) are planted as normally and annuals crops (rice, maize, cassava, sweet potato, avocado, vegetables, gingers, canna, species, medicinal ...) are intercropped in the inter-rows of the trees. The annuals can accompany the trees along the whole life of the trees, or only during the first years of the establishment of the trees, depending on the households’ preference and purpose.

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21 Source: Nguyen Huu La (2014)
22 [http://m.baodaknong.org.vn](http://m.baodaknong.org.vn)
(13) **Systems of main crops together with timbers as shading/protecting/supporting plants** (main crops + forest trees for shading/supporting/protecting purpose): Conventionally these systems have been practiced with the aim to protect and/or support the main crops, such as:

- in locations with problems of strong winds or sandy soils, trees (bamboos, conifers...) are planted as fences for protecting crops and lands from these problems (Le Trong Cuc, 2011).

- for crops, such as coffee and tea, which grow better when are partly shaded, evergreen trees, most often Cassia and Melia are planted at a suitable density for shading and also from protecting crops from frost.

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23 Photos taken by Pham Thi Sen  
24 Photo taken by Pham Thi Sen  
- for creepers (pepper or dragon fruits, for example) trees (e.g. senna) are planted as support for them to climb over.

Nowadays, trees of multiuse values are increasingly used, such that in addition to the ‘original value’ of protection, supporting or shading, they also generate economic income for households. For examples, fruits trees or timbers of high values such as macademia, melia chukrasia, peach, durian, pines... are planted.

3. Status of agroforestry research and development

Vietnamese farmers have been practicing agroforestry long ago. Most of them, nowadays, however are unfamiliar with the term “agroforestry” and, this demonstrates that not much efforts have ever been spent for research and development of this sub-sector. As mentioned before, since long ago, most people of Vietnam have practiced systems of mixed gardens which combine annual crops, perennial crops, non-timber and timber forest plants in homesteads or in other land areas, with or without animals raised underneath of trees (Pham Thi Sen at al., 2008). Latter, since 1960s, inputs have been spent for developing intensive production of mixed gardens towards increased income for their owners. Also, since then two traditional landscape models, VAC and VACR, have been studied and promoted (Ngo The Dan, 2008; Nguyen Thi Hoa and Catacutan, 2013). Currently, mixed gardens and VAC are the most popular systems, practiced by many households in all the villages crossing the whole country’s territory. The second most popular systems are VACR which are frequently found in the uplands but can also be practiced in the lowland regions. Together with increasing inputs spent for agricultural and forestry sectors, increasing demands for diverse plant and animal products, and urgent needs for steady growth of production and income, other agroforestry systems as mentioned above have also been studied, designed and promoted. Germplasm collecting, characterisation, conservation, documentation and development also enjoyed increasing attention. Nevertheless, research gaps are still to be closed (Huy Dap and Vo Hung, 2013).

- Germplasm collection, characterization, conservation and documentation

According to the preliminary survey data (MARD, 2005), there are more than 800 plant species cultivated in the country, including 41 starchy food, 95 non-starchy food, 105 fruit, 55 vegetables, 44 oil, 16 fibber, 12 beverage, 181 medicinal, 39 spice, 29 cover, 50 ornamental, 49 woody and 5 shading species.

Regarding the agricultural crops: The Plant Resources Centre together with the member institutions of the national network of agricultural plant genetic resources have collected and
maintained almost 26,500 germplasm accessions of 140 species (La Tuan Nghia at al., 2013), including 80 orthodox seed species in the seed genebank and 60 non-orthodox seed species and asexually propagated species in field or in vitro genebanks. All of these accessions have been preliminarily characterized and, all accessions of the most important crops maintained at the national genebank (rice, beans, some vegetables) have been characterized and documented.

For medicinal plants: The National Institute of Medicinal Materials (NIMM) has collected and maintained almost 900 medicinal plants species, of which 888 species have been preliminarily characterized, 250 species have been characterized and documented (http 1).

For forest trees: The Vietnamese Academy of Forest Science (VAFS) has studied genetic diversity of 100 species, collected and maintained 109 accessions of 76 species, both planted and wildly growing (Phi Hong Hai, 2010; http 2). Under the national afforestation programme (Program Nr. 327), 104 species have been identified as suitable for forest planting in the country, among them are also threatened and local valuable and rare species, such as *Parashorea chinesis* (chò chỉ), *Diptericarpus alatus* (dầu rái), *Pterocarpus marocarpa* (giáng hương quá to), *Talauma* (giỏi), *Aflezia xylocarpa* (gỗ dò), *Cupresus torulosa* (hoàng dàn), *Taxus chinensis* (thông dố bậc), *Cephalotaxus manii* (dính tùng), *Pinus kwangtungensis* (thông pà cò) etc. (http 3).

The numbers of accessions and species collected and conserved are summarized in Table 2.

**Table 2: Numbers of accessions and species of agricultural and forest plants conserved**

<table>
<thead>
<tr>
<th>Agricultural plants</th>
<th>Number of accessions</th>
<th>Number of accessions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cereals (seed genebank)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Rice</td>
<td>7,883</td>
<td>39. Taro</td>
</tr>
<tr>
<td>2. Sorghum</td>
<td>177</td>
<td>40. Cassava</td>
</tr>
<tr>
<td>3. Millet</td>
<td>94</td>
<td>41. Yams</td>
</tr>
<tr>
<td>4. Wheat</td>
<td>156</td>
<td>42. Sweet potato</td>
</tr>
<tr>
<td>5. Maize</td>
<td>661</td>
<td>43. Kudzu</td>
</tr>
<tr>
<td>6. Oat</td>
<td>54</td>
<td>44. Canna</td>
</tr>
<tr>
<td>7. Coix</td>
<td>68</td>
<td>45. Alpinia</td>
</tr>
<tr>
<td><strong>Legumes (seed genebank)</strong></td>
<td></td>
<td>Curcuma</td>
</tr>
<tr>
<td>8. Beans of different kinds</td>
<td>1,521</td>
<td>46. Ginger</td>
</tr>
<tr>
<td>9. Cajanus</td>
<td>15</td>
<td>47. Medicinal plants</td>
</tr>
<tr>
<td>11. Soybean</td>
<td>526</td>
<td><strong>Fruits (Field collections)</strong></td>
</tr>
<tr>
<td>12. Peanut</td>
<td>341</td>
<td>49. Banana</td>
</tr>
<tr>
<td>13. Seasame</td>
<td>305</td>
<td>50. Guava</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>15.</td>
<td>Yam bean</td>
<td>57</td>
</tr>
<tr>
<td><strong>Vegetables (seedgenbank)</strong></td>
<td></td>
<td>53.</td>
</tr>
<tr>
<td>16.</td>
<td>Gourds of different kinds</td>
<td>997</td>
</tr>
<tr>
<td>17.</td>
<td>Egg plants</td>
<td>325</td>
</tr>
<tr>
<td>18.</td>
<td>Tomato</td>
<td>253</td>
</tr>
<tr>
<td>20.</td>
<td>Melon and cucumber</td>
<td>310</td>
</tr>
<tr>
<td>22.</td>
<td>Spices of different kinds</td>
<td>826</td>
</tr>
<tr>
<td>23.</td>
<td>Basella</td>
<td>100</td>
</tr>
<tr>
<td>24.</td>
<td>Luffa</td>
<td>399</td>
</tr>
<tr>
<td>25.</td>
<td>Pot-hear</td>
<td>57</td>
</tr>
<tr>
<td>26.</td>
<td>Amanranthus</td>
<td>212</td>
</tr>
<tr>
<td>27.</td>
<td>Letuce</td>
<td>15</td>
</tr>
<tr>
<td><strong>Industrial crops (Field collections)</strong></td>
<td>66.</td>
<td>Papaya</td>
</tr>
<tr>
<td>28.</td>
<td>Cocoa</td>
<td>170</td>
</tr>
<tr>
<td>29.</td>
<td>Arabica coffee</td>
<td>153</td>
</tr>
<tr>
<td>30.</td>
<td>Robusta coffee</td>
<td>87</td>
</tr>
<tr>
<td>31.</td>
<td>Cashew nut</td>
<td>49</td>
</tr>
<tr>
<td>32.</td>
<td>Cotton</td>
<td>544</td>
</tr>
<tr>
<td>33.</td>
<td>Pepper</td>
<td>23</td>
</tr>
<tr>
<td>34.</td>
<td>Tea</td>
<td>192</td>
</tr>
<tr>
<td>35.</td>
<td>Mulbery</td>
<td>154</td>
</tr>
<tr>
<td>36.</td>
<td>Sugarcane</td>
<td>98</td>
</tr>
<tr>
<td>37.</td>
<td>Fodder and grasses</td>
<td>60</td>
</tr>
<tr>
<td>38.</td>
<td>Cover and soil protection</td>
<td>64</td>
</tr>
</tbody>
</table>

**Forest trees**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Eucalyptus (seed bank)</td>
<td>11 species</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Acasia (seed bank)</td>
<td>6 species</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Native species (pine, melia, casuarina, lacquer,</td>
<td>30 species</td>
<td></td>
</tr>
</tbody>
</table>
• **Production and certification of planting materials and variety development**

MARD (the Ministry of Agriculture and Rural Development) has the role to exercise the state management over crop seeds produced and supplied by all sources. The government policy is to encourage and support all people and organizations to participate in crop varietal improvement as well as in quality seed production & supply, as specified in the Ordinance on Crop Varieties/Seeds Management (2004) and Decree on Plant Varieties/Seeds Management (1996).

At the present, crop seed production and supply in Vietnam involves formal and informal, private and government supported systems.

The government supported seed systems include:

- At the national level: There are South Seed Company and North Seed Company involving in production, import and supply of seeds of important food crops (rice, maize, vegetables, fruits).
- Provincial seed companies/centres produce, improve and supply seeds (mostly foundation and certified) of important crops (rice, legumes, potatoes, fruits)
- Companies belonging to research institutions: seeds of all kind of crops, but with focus on main crops
- Agricultural cooperatives: mostly rice and fruits

The private seed systems: include private companies (local and international), groups of household groups (communities’), and households.

In general, informal systems are supplying a large part of seeds amount used in the production, especially for ‘less important’ crops. The share of seeds supplied by formal systems depends largely on crops, varieties and locations. For example, for maize, the formal seeds represent around 80% of the total seeds amount used in the production, while for fruits and other perennial plants the figure is only around 20%. Farm-seeds still occupy a significant ratio. In particular, seed of local varieties and traditional crops are mainly produced on-farm. The flows of farm-seeds are presented in Diagram 4.
Diagram 4: Informal seeds flows

Regarding forest trees: Seeds or seedlings are produced and supplied by nurseries which can be divided into the following groups (Roshetko at al., 2011):

- Institutional nurseries (of research institutions, local government, private enterprises) for market sales, and a small portion for research objectives.
- Project nurseries (of provincial, national or NGO Projects) produce seedlings for planting in the target areas of the projects/programs.
- Group nurseries: community or groups of households mainly produce tree seedlings to rehabilitate their own land (75%) or for market sale (25%) through informal market channels.
- Household nurseries produce seedlings mainly for household use and a small portion for selling/exchanging among the communities (informal system).

In 2010, according to Nhu Van Ky (2011), in Vietnam there were over 2,000 nurseries, including 600 government-supported (of state companies or research institutions and of local governments), 1,400 private, and about 20 others, e.g. communities’ or projects’ nurseries (Diagram 5).

The household and community (farm) nurseries are normally small-scale, often produce less than 100,000 seedlings per year while the state run and private enterprises’ nurseries often produce much bigger amount of seedlings.
The above mentioned high diversity of sources and channels and small scale of seed producers cause great challenges to seed quality control. As seen, a large part of seeds/seedlings used in the production are from informal systems, i.e. not registered, and thus their quality is not subjected to any monitoring/controlling protocol. On the other hand, criteria for quality of seeds have only been developed for main crops, not yet for local and traditional plants and, not yet for crops and plants which are considered as ‘secondary’ or of less importance. Therefore it is difficult for monitoring/controlling quality of seeds/seedlings of these crops. Another problem, as mentioned by Nhu Van Ky (2011), is that there are a large number of seed enterprises of which many are based in difficult and far locations, and the current system of seed quality control has not enough capacity to cover all of them.

In term of technical aspects, there are crops and trees which can be ‘easily to be propagated’ and hence their seeds/seedlings are often produced in surplus, exceeding the demands. In contrast, of ‘difficult to be propagated’ plants the mounts of seeds produced are far from enough to meet the demands. Seed production of most producers are not yet market-oriented. Technical support and capacity building are necessary for small-scale enterprises and communities/households to produce and supply quality seeds. At the present, however, many of these seed producers do not obtain enough support.

In term of markets, small-scale seed producers often can not sell their seeds to government projects for forest or agroforestry systems establishment because their seeds are not registered, while the amounts of registered seeds (supplied by the formal systems) are not enough to meet the demands. On the other hand, there are many informal market channels of seed supply, and hence it is difficult to monitor both seed quality and quantity.
In term of variety improvement, due to high levels of diversity in climate, soil and ethnicity, and because of increasing problems of climate variability and extreme conditions (drought, saline, submergence, frost, winds, sands...) in order to develop agroforestry systems appropriate for diverse contexts diverse crop varieties and plant species with stress tolerance and adaptability to different growth conditions are required. However, the breeding system, up to now, have been focused mostly on main crops and aiming at high yielding varieties. Traditional, local crops and plants of less ‘importance’ in term of production area have not enjoyed enough attention. Thus, there is a lack of varieties and plants with tolerance to drought, saline, submergence, cold and/or heat suitable for specific local conditions in different locations for agroforestry systems development.

- **Processing, value addition and product development**

Nowadays, more and more households practice agroforestry for commercial purposes, and economic analysis data (Le Trong Cuc, 2011; Nguyen Huu La, 2014; Nguyen Mai Phuong and Catacutan, 2015) show that the above mentioned systems bring better benefits for households compared to most agricultural systems of monocultivation. For example, the economic analysis of a system of forest-upland field-gardens-livestock (forest + coffee + fruits + annuals + livestock) in Lam Dong province (Hoang Dinh Quang and Tran Van Thin, 2010) show that this system bring a return of over VND 200 mil./ha, and for each VND spent households earn VND 5.6 in return.

One of the main problems however is related to poor market linkage or volatility of prices. In general, in Vietnam, markets for most crops and timbers much vary between seasons, years and locations. There are not a sustainable linkages for products, and not suitable effective market regulatory mechanisms. Difficulties in transportation (long and bad roads) and lack of postharvest/processing technologies bring additional problems. Often, farmers relay totally on the local traders/collectors for selling their products, and generally there are not contracts for selling/buying.

Most part of non-timber products (flowers, corks, leaves, fruits, essential oils and so on) of such trees like cinnamon, illicum, cajuput are often sold as raw materials to private enterprises for processing. A significant part is exported, either as raw materials or as processed products. Some kinds of leaves, flowers are also used as spices for some specialty dishes

Products of industry trees (tea, coffee, rubber, cashew, coconut, cacao...) are mainly for sold as raw materials to local factories for processing. Some part of such products as tea and coffee, are also preliminarily processed by households (mostly drying) before selling. Some households do this kind of postharvest activities with the aim to keep products for selling at better time (for better prices). However, as households are in limited connection to markets and have limited knowledge in postharvest and marketing, the values they add to products are
often very small, sometimes can be under zero\textsuperscript{26}. Processed products are consumed at the local markets or exported to different countries.

Fruits are mainly sold and consumed as fresh products through local collectors. Postharvest technologies remain backwards.

Timbers are sold directly or indirectly through local collectors to local enterprises for processing, and semi-processed timber products (Picture 14) are for paper production in the country or for exportation.

\begin{center}
\textbf{Picture 14: Processed timber products ready for transportation to different markets}\textsuperscript{27}
\end{center}

4. Status of education in agroforestry

To develop of a production system in Vietnam, as normally, many stakeholders have roles in. While the households play the most important and decisive role, their neighbours though sharing of information and experiences can influence the owner household’s decisions. Local authorities at different levels can also play a valuable role; policies or plans implemented by them can result in significant changes in the local production systems, including agroforestry. Markets, as usual, can be drivers or barriers for development of a system. Researchers and

\textsuperscript{26} Reports of value chain analysis for arabica coffee and shan tea in some northwest province by MCG (2015) under the CSA project, available at NOMAFSI

\textsuperscript{27} Photo taken by Pham Thi Sen
extension officers have role in building capacity and supporting households in term of plant management aspects. Local mass organizations (namely gardening association and farmers association) can play the liaison role between local authorities, research institutions, extension network and households. Thus, for effective development of agroforestry systems all these stakeholders should be included in the education target beneficiaries.

Nowadays, the subjects of agroforestry have been included in university education as well as agricultural extension programs. Specialised subjects are taught at agriculture and forestry universities, such as Thai Nguyen University of Agriculture & Forestry (TUAF), Hue Agriculture and Forestry University (HAFU), Agriculture and Forestry University of Ho Chi Minh City (HCMUAF) and Vietnam National University of Agriculture (VNUA). Some networks for social experience and information sharing relating to agroforestry have also been established, (e.g. Vietnam Network for Agroforestry Education (VNAFE) and Social Forestry Training Network (SFTN).

VNAFE is a National Network belongs to Southeast Asian Network for Agroforestry Education (SEANAFE). The Network is supported by the Swedish International Development Cooperation Agency (SIDA). The website of VNAFE is http://www.socialforestry.org.vn. Members of VNAFE include:

- Vocational School for electricity, agriculture & forestry workers in Northeast (VSEAF)
- Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI)
- Thai Nguyen University of Agriculture & Forestry (TUAF)
- Vietnam Forestry University of Vietnam (VFU)
- Hue Agriculture and Forestry University (HAFU)
- Tay Nguyen University (TNU)
- Extension Centre of Lam Dong Province
- Agriculture and Forestry University of Ho Chi Minh City (HCMUAF)
- Da Lat University (DLU)

SFTN: Under the Social Forestry Support Program (SFSP) supported by SDC the Social Forestry Training Network of Vietnam (SFTN) was established in 2002. Members include TUAF, SFRI, VFU, HAFU, TNU, HCMUAF and extension centers of some provinces.

The above mentioned two network and their members are also providers of trainings to farmers, extension officers and students. They also support MSc. and PhD students in conducting their thesis research.

It is also worthy to note that the government extension networks with centres, stations and officers based in all provinces, districts and villages play great role in development of agroforestry systems all over Vietnam. With the involvement of the extension network every year thousands of farmers and local staff are trained.
In general, the flows of technologies to farmers in Vietnam are as illustrated in Diagram 5. According to survey data by NOMAFSI (2013), the government extension officers (belonging to DARD) are the main ‘communicators’ with farmers for technical innovation diffusion. Following them are (i) farmers-to-farmers, and (ii) production inputs providers.

Nevertheless, agroforestry has not been obtained enough attention. Both education and research efforts on agroforestry have been included as a part of either agricultural or forestry efforts. Agroforestry had not been considered as a sub-sector.

![Diagram 6: Technologies flows to farmers in the northern mountainous region](image)

5. Proposed approaches and priorities for meeting the emerging challenges, constraints and opportunities

The main challenges and constraints to agroforestry in Vietnam are related to:

- Small scale of households and high diversity of small-volume-products: this is especially a problematic in the northeast, northwest and north-central coastal regions. When households practice agroforestry at small scale (ranging from few tens to few hundreds of square meters), in term of volume, their products are too much for household consumption and too little for commercial purpose.

- Limited and/or unstable markets for the products: “When one farmer produces a product the price is high, when 10 farmers produce the same one product no body buys” – this is normally said by farmers for products aiming at local community

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28 Source: Pham Thi Sen et al. (2015)
markets. For products aiming at national indoor or export markets, the requirements for quality, uniformity, long road-life, long shelf-life cause problems as our farmers are with different levels of knowledge, financial capacity and preference, and are in lack of postharvest technologies.

- Lack of suitable technologies: Regarding the crops, up to now, efforts have been focused mainly on monocultivation technologies for increased yield and income. Not much attempts have been spent for developing techniques for intercropping them into different agroforestry systems. The same is true also for forest plants, both timber and non-timber; Efforts have mainly aimed to develop technological innovations for planting trees in planted forests, not for planting them in agroforestry systems under different ecological conditions.

- Lack of suitable species/varieties, and lack of knowledge to select suitable species/varieties, for different agroforestry systems in different contexts: This problem becomes increasingly important nowadays due to increased problems caused by climate variability and increased demands for diverse and quality products.

- Limited availability of quality seed/seedlings: As many plants in agroforestry systems are not considered ‘main’ crops, they have not enjoyed much attention for their varietal improvement, as well as for their seed quality control and improvement.

- Lack of thorough study of economic, environmental and social impacts of agroforestry systems of different types in different ecological regions of Vietnam: This causes problems for planning and selecting of priority systems in concrete contexts.

- Difficulties in application of mechanisation for agroforestry systems: This in turn leads to increased requirement of labour inputs which is indeed an increasingly serious problem for most households.

*The main strengths and opportunities are related to:*

- Rich and diverse traditional and indigenous knowledge of farmers: As mentioned above, in all regions, farmers have long been practicing different kinds of agroforestry practices and systems.

- Rich and diverse genetic resources which, as mentioned above, have been studied, collected and maintained for both long- and short-term use purpose.

- Increasing demands for specialty products of local and traditional plants and varieties: Especially, with the adoption of market-oriented economy policies, market possibilities for such kind of agroforestry products also increase.
- Developed government extension network and traditionally close within-community relationships: This greatly facilitates the diffusions of knowledge among farmers, both within and between communities.

- There are institutions and networks involved in the research and education in agroforestry.

**Proposed approaches and priorities**

- To develop techniques for production and postharvest of plants suitable for farmers to adopt in diverse agroforestry systems in diverse contexts. The requirement of labour inputs as well as farmers’ traditional knowledge and culture should be taken into consideration for technology development;

- To strengthen research and development of market links for the products;

- To identify incentives for private sector and to implement policies/mechanisms supporting the private sector to participate in the value chains of agroforestry products;

- To conduct impact analysis of different agroforestry systems, to study indigenous knowledge of farmers as well as socio-economic and natural conditions in different regions, and to define potential priority systems for each concrete context;

- To improve seed/seedling quality and to diversify varieties and plant types suitable for diverse systems in diverse conditions. This includes development of nursery industry and strengthening of breeding and germplasm exploitation activities.

- To promote collective actions through applying landscape and community land use planning approach to overcome the problems of small-scale households.

- To strengthen capacity and awareness raising using the available network and institutional arrangement

**6. Summary and conclusions**

Since long ago Vietnamese farmers have already been practicing agroforestry. Nowadays there are 13 types of agroforestry systems in the country, of which two types, including (i) systems of intercropping annuals in to orchards or industrial trees and (ii) systems of crops with shading/protecting/supporting trees, may not be considered agroforestry as fruit, industrial and shading/protecting/supporting trees are not considered forest plants in Vietnam. Other 2 types of systems, including (i) mixed gardens and (ii) VAC are most popularly practiced, in all villages throughout the country. Second most popular are systems of VACR and systems of intercropping of perennial or annual crops into forests. Other systems, such as mangrove + aquaculture or melaleuca + rice + aquaculture are only practiced in locations flooded with
saline water. Systems of integrating animal husbandry in forest is also practiced in many locations.

Each of these 13 types in turn includes diverse agroforestry systems with high levels of diversity in terms of the layout as well as in terms of species and varieties/breeds produced, depending on the local climate, water, soil, topographical and market conditions and also on the household capacity, purpose and preference.

Nevertheless, nowadays most of farmers remain unfamiliar with the term “agroforestry”, and this is one of the indicators that not much effort has been spent for education in, and for research and development of, agroforestry in the country. There are gaps to be closed among them the most important are relating to developing plant management technologies, nursery industry, varietal and plant type diversification, strengthening capacity and awareness for collective actions, improving involvement of private sector and, developing market links.

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