CORE Project

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Learning Guide to Traditional Orchards

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The CORE European Project is an Erasmus + Partnership project (2019-2022) with partners in the UK, Poland, Germany, Hungary and Italy

Who is it for? Orchard owners, managers, volunteers and trainers who want to learn and teach adults about traditional orchards.

Learning Toolkit for Traditional Orchards

Case Studies

pdf file downloadable from website

Part 1 - Learning and teaching about traditional orchards

Aim

To introduce approaches to learning and teaching about traditional orchards and the characteristics, value, conservation and management of their heritage fruit and nut trees.

Learning objectives

The learner should be able to know about, understand, describe and demonstrate:

- **The characteristics and range of traditional orchards.**
- **The value of traditional orchards.**
- **The issues and challenges for the revival of traditional orchards.**
- **The opportunities and approaches for teaching about traditional orchards.**
- **The ways of protecting and conserving orchards.**

1 What are traditional orchards?

There are many types of orchards around Europe. However they are all defined as collections of cultivated fruit and/or nut trees or shrubs that are maintained for food production which may be for commercial, domestic or community use.

Traditional orchards are dominated by older, less intensively-managed standard trees, with main branches above the reach of grazing animals, and planted at relatively low densities.

In contrast to intensive commercial orchards the traditional orchard is defined by low inputs and outputs, low labour and mechanisation, high biological diversity and high landscape value.

Traditional orchards

- **A group of fruit trees** – often several different species and many old local varieties of varying age, often with small areas of polyculture.
- **Grown on vigorous, standard rootstocks** - with long-lived trees on tall trunks (up to 200 years old for pears).
- **At low density** (about 150 trees/ha) – sometimes with other crops between rows.
- **In permanent grassland** – mown (often for hay) or grazed by cattle or sheep.
- **Managed in a low intensity way** – with little or no chemical input, some restorative pruning and often dead or decaying wood.

- **For multiple products** – including fruit, juice, alcoholic drinks, nuts, meat, milk, honey, hay, timber, wood products etc.
- **With low or variable fruit productivity** – eg. 10 tonnes/ha.
- **With high biological diversity, landscape and cultural value**.

Modern, intensive, commercial orchards

- **A group of fruit trees** - a few modern varieties of similar age, often with large areas of monoculture.
- **Grown on dwarfing rootstock** – at close spacings in rows, with fruit able to be picked by hand or machine.
- **At high density (about 2100 trees/ha)** – usually in rows as a hedge for picking without ladders.
- **In rows of bare ground/ mown grassland** – frequently mown or sprayed.
- **Managed in a high intensity way** – with pesticides, herbicides and inorganic fertilisers, and intensive pruning.
- **For single products** – including fresh or stored fruit, processed juice.
- **With high fruit productivity** – 30-50 tonnes/ha.

Formal definitions of traditional orchards

Germany

Streuobstwiese - Orchard meadow. **Streuobst** – Orchards.

The orchard meadow is a traditional form of fruit growing. Tall fruit trees, mostly of different ages and different types and varieties, are scattered across orchards. In contrast, modern, intensive fruit growing is characterized by low-stemmed fruit varieties in monoculture. This is characterised by multiple use. The trees are used for fruit production ("overuse"). As the trees are loosely positioned, the area also serves as grassland (“underuse”), either as a hay meadow for hay or directly as pasture for cattle.

“Orchard cultivation is a form of extensive fruit cultivation, in which, for the most part, strong-growing, tall-stemmed and large-crowned fruit trees are spaced widely. Regular underuse as permanent grassland is characteristic of orchards. There are also orchards with agricultural or horticultural underuse, and other linear plantings. Often, orchards are composed of fruit trees of different types and varieties, age and size classes. They

should cover a minimum area of 0.15 ha. In contrast to modern dense plantings with closed, uniform plantings, the individual tree is always recognisable in orchards."

Ref – **Orchard definition for Germany**

England

"Traditional orchards are defined as five or more trees, where the distance between the crown edges is 20 m or less.

- They are characterised by the presence of either standard or half-standard fruit trees, grown on vigorous rootstocks and planted at low densities (usually less than 150 trees per hectare) on permanent grassland.
- Mature trees should have 90% of their foliage above 1.5 m, with trunks that are either at least 1 m in circumference at the base or form their first major fork at least 1.5 m above ground level."

Ref – **Orchard definition for England**

Hungary

szórványgyümölcsös - Traditional orchards

Fruit-growing areas with less intensively cultivated, non-intensively cultivated fruit trees of different ages and variations in species and variety composition are considered traditional orchards. No chemicals are used in the orchards. The grassland under the trees are mown or grazed.

The most common fruit trees in these orchards are plums, along with many apples, pears, cherries and nuts. The varieties found in traditional orchards are mainly landscape varieties (e.g. Sóvári and Batul apples) and historical variants.

Poland

Tradycyjny sad – Traditional orchard

A traditional orchard is an orchard where trees of traditional varieties are grown. These varieties are listed and attached to the Ordinance of the Minister of Agriculture and Rural Development on the detailed conditions and procedures for granting financial aid under the measure "Agri-environment-climate" under the Rural Development Program for 2014–2020. This regulation concerns aid for the maintenance of traditional orchards. Annex 4 to the regulation lists almost 100 varieties of apple trees, nearly 30 varieties of pear trees, a dozen varieties of sweet cherries and sour cherries, and almost 10 varieties of plums. Payments will be made to orchards of traditional varieties of fruit trees, including at least 12 trees, propagated on vigorously growing rootstocks and kept as tall-stemmed trees (minimum trunk height is 1.2 m), aged 15 years and over, representing no less than 4 varieties or species. The trees should grow at a distance of not less than 4 × 6 m and not more than 10 × 10 m, and at the same time the number of these trees per 1 ha of the orchard area should not be less than 90. In the orchard submitted for payment, it will be necessary to perform certain maintenance procedures (pruning trees, mowing grass, etc.).

Ref - **Information - Package 3. Preservation of orchards with traditional varieties of fruit trees**

2 The value of traditional orchards

The traditional orchard has multiple functions. They follow the principles of sustainable development in balancing economic, social and environmental factors. But the main

function is determined by the landowner or manager.

- **Productivity** – Traditional orchards are the archetype of sustainable agriculture – an agroforestry ecosystem similar to wood pasture and parkland. They can combine fruit, livestock and pasture systems. The hedges or borders may also include fruit and nut trees. Seasonal or fixed bee hives are also a feature of traditional orchards.
- **Biodiversity** – Traditional orchards are now hugely importance for west and central European biodiversity. The varied habitats of old trees, dead and decaying wood, hedgerows and permanent pasture provide the rich, small-scale orchard ecosystem.
- **Agrobiodiversity** – Traditional orchards hold many rare local fruit and nut varieties. Future crop breeding will need the genetic diversity of these varieties.
- **Cultural heritage** – Traditional orchards have been managed for over 2,000 years across Europe. The inherited knowledge, skills and traditions of farmers and growers is also important to conserve. Agrotourism and the heritage industry increasingly relies on conserving and re-creating the life of a traditional orchard. It can provide an economic boost to disadvantaged rural regions.
- **Amenity and recreation** – Traditional orchards are increasingly recognised as worthy of conservation and establishment as public amenity spaces. Local community organisation and social enterprises are providing opportunities for people to volunteer and learn about managing fruit trees and orchards in a social setting.
- **Health and wellbeing** – Traditional orchards are places that are closely associated with wellbeing in terms of good health, good food and a good landscape. So it is natural to consider traditionally managed orchards as a healthy environment for both people, fruit trees and the whole orchard ecosystem. The beauty of a blossoming and bountiful orchard is also an important experience and memory for many people.

Ecosystem Services

These multiple functions can now be measured and described in terms of ecosystem services related to:

- **Regulating** - Sequestering (or storing) carbon in the plants and soil, controlling flooding, improving air quality and boosting pollinating insects.
- **Supporting** - Boosting and conserving biodiversity.
- **Providing** – Providing food and conserving genes for future breeding.
- **Experiencing** – Experiencing beauty, education, heritage, recreation and wellbeing.

Traditional orchards are an increasingly rare type of orchard that was previously common throughout Europe. Their mosaic of habitats, mixture of species and old locally propagated varieties makes them rich, biodiverse ecosystems. Now the sustainable future of agriculture needs such agroecological systems of agroforestry as well as the agrobiodiversity of local varieties of fruit and nut trees to support a resilient food supply in the face of climate change.

3 Decline of traditional orchards

Traditional orchards, unlike intensive commercial orchards, are declining throughout

Europe. In 1930-1950 in Europe, about 2 millions hectares, mainly in France and Germany but also in Poland, England, Belgium and Spain, were covered by traditional orchards (“pré-verger” in French and “Streuobswiesen" meaning meadow or scattered orchards in German). This form of fruit production was traditionally grown on arable land, undersown with crops or grassland. Since 1950 this European agroforestry system has significantly declined. More than 80 percent of all traditional heritage orchards have disappeared across Europe within the past 60 years.

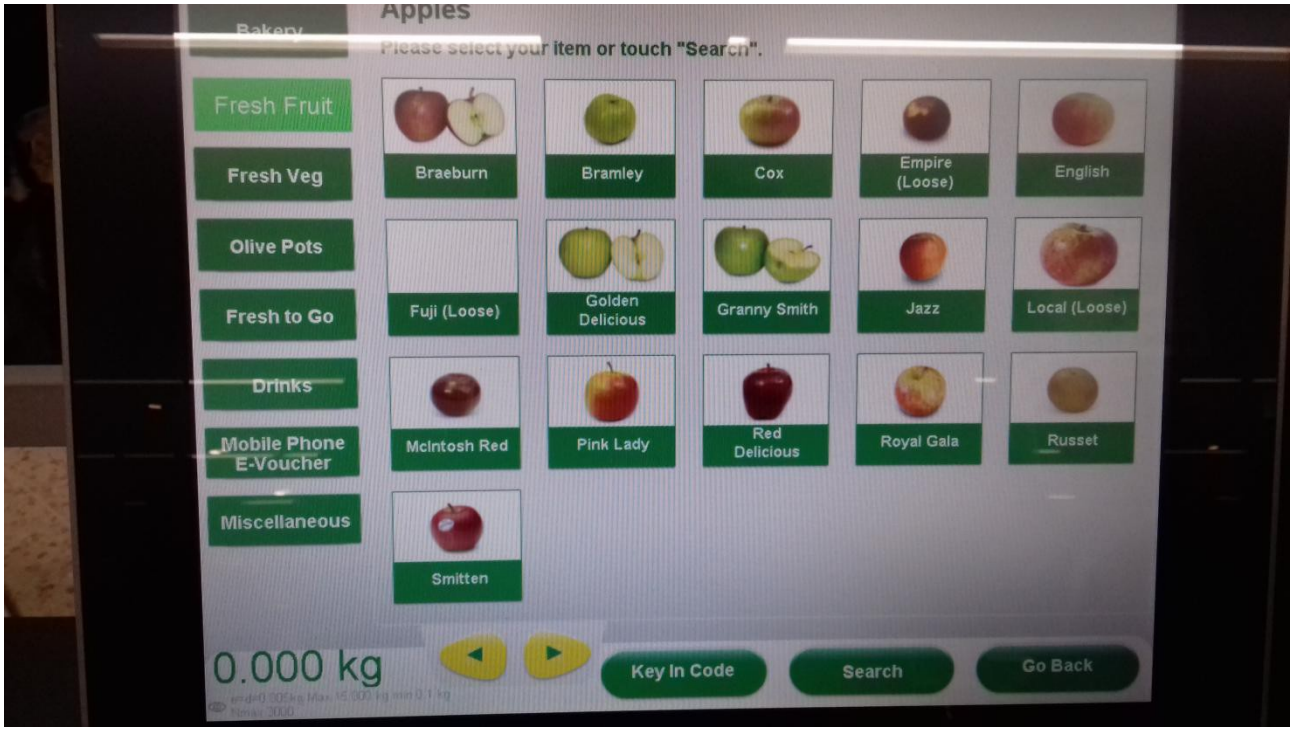
Ref - ESTO Project

Main issues and threats

Global scale

Consumer demand and international trade regulations have favoured:

- Cheap imports
- of a few varieties of standardised tree fruit
- grown in highly intensive, mechanised and large-scale commercial orchards
- made available throughout the year.



Local scale

- **Management** - Insensitive and unskilled management has reduced the biodiversity value of orchards.
  - Plans for re-planting orchards have not been developed. So they are in danger of rapidly degenerating without a rolling plan for the replacement of older fruit trees giving a mixed age profile.
  - Horse grazing has a number of deleterious effects eg. chewing bark.
  - Overwintering livestock have chewed bark with spillage of fodder over-enriching the ground.
  - Dying trees or parts of trees have been removed.

- **Agriculture** - Orchards have been removed or fragmented to be replaced by more financially productive use of the land for agriculture.
- **Housing development** – Orchards, especially on the borders of towns or villages, have been removed or fragmented for new housing or industrial developments. Planning controls are weak. If the orchard is designated as a "brownfield site" it may be developed for housing etc. Speculative removal of orchards may sometimes precede building permission.
- **Isolation**- The ongoing decline in traditional orchards tends to isolate remaining orchards with consequent local extinction of less mobile species.
- **Lack of marketing activities** - The value of traditional orchards and their products have not been as well marketed as the products of large commercial growers and processors. There is no publicly promoted accreditation scheme for traditional orchards.

4 Revival plan

Across Europe it now appears that the community and voluntary sector is the champion for conserving traditionally managed orchards. So the focus of this CORE project is education by that sector about the value, conservation and management of these orchards, as well as strategies for marketing their products.

The plan for education about:

- **Identifying, monitoring and maintaining** the current orchards.
- **Improving** traditional orchard management and increasing the number and area of orchards managed traditionally.
- **Restoring** degraded orchards by in-fill planting, restorative pruning and extending their size.
- **Establishing** additional orchards by identifying suitable sites, managers and management plans.
- **Enhancing** and promoting the economic, cultural, health and wellbeing values of traditionally managed orchards.

Growing demand from:

- **Farmers and landowners** - for learning more about agroforestry and agroecology systems as elements of the new EU and UK agricultural funding.
- **Growers and gardeners** – for learning the skills of managing orchards eg. grafting, and pruning. For example in the last 7 years SustEd has organised grafting and pruning courses for 140 adults, most of whom are low skilled and unemployed.
- **Consumers** - for knowing more about and buying heritage fruit tree products from named sustainable orchards. Also for their consumption of organic, vegetarian and vegan food and drink.
- **Producers** - for growing and processing heritage fruit tree varieties.
- **Social enterprises and community orchard groups** - for researching and reviving lost fruit varieties and traditional orchards. Also for using community orchards as part of horticultural therapy and to promote healthy eating and wellbeing.
- **Orchardists** - for networking with other traditional orchard managers and educators.

Challenges for the revival

There are several key challenges for conserving and enriching traditional orchards across Europe.

- **Consumer demand** – There is a need for better, more cooperative marketing of the products and values of traditional orchards.
- **Legal protection** – There is a need for more local and national legislation and planning control to protect the cultural, landscape and biodiversity value of traditional orchards and resist alternative land use developments such as housing. This will need better recording and monitoring of the biodiversity of orchards.
- **Training of orchardists** – There is a need for more training, especially of younger adults, about the traditional management of orchards, such as grafting, pruning, processing fruit and managing with nature. There are low skills and poor understanding amongst many farmers, gardeners and growers.
- **Age** – There is a need for younger orchard owners, managers, workers and volunteers. Orchard workers are relatively old compared to other industrial sectors – probably older than any other sector!
- **Cooperation and networking of orchardists** – There is a need for better, more cooperative marketing of products from traditional orchards in the face of competition from more intensively managed orchards, and misunderstanding by the consumer.
- **Ecotourism opportunities** – There is a need for encouraging and supporting landowners, especially farmers and campsite owners, to develop traditional orchards as an additional part of their agrotourism or eco-camping offer.
- **Community opportunities** – There is a need for interested communities to have more access to land, especially in urban and suburban areas, for creating publicly-accessible orchards and reviving neglected orchards. These could be based on legal and long-term agreements with private or public landowners. Private orchard owners could also encourage and involve more volunteers, especially to avoid orchards being neglected.

Protecting orchards

Legal protection

Each country will have its own laws and regulations about the protection of orchards and fruit trees. They may prohibit the removal or felling of trees based on criteria such as age, trunk diameter at 1.5 m, public accessibility and visibility, type of orchard, views of the owner and neighbours etc.

Restoring orchards

In several countries (eg. Germany and England) there is funding from central or regional governments to restore traditional orchards. They can be restored by firstly surveying and identifying the fruit tree varieties, then the biodiversity of the whole orchard, and lastly by restorative pruning over several years.

Enriching orchards

All orchards can be continually enriched by managing in a sustainable and wildlife-friendly way. As orchards age there can be more diversity in the age and variety of the fruit trees, the height and diversity of the grassland sward, the diversity of the orchard

boundary or hedge, and the diversity of visiting and resident wildlife.

5 Types of orchard

Across Europe there are many different types of traditional orchard in terms of ownership, size and accessibility.

- **Household orchard -** Small privately owned orchard with a crop for domestic consumption.
- **Farm or smallholding orchard -** Privately owned orchard with a commercial crop. Some may have grazing livestock and on-farm processing for juice or cider. Historically these were the commonest traditional orchards, often for domestic consumption on every farm in a suitable growing area.
- **Open community orchard** – A community orchard group of volunteers may manage the orchard. The group is often a not-for-profit organisation able to raise funding with trained, enthusiastic volunteers. Any member of the public is able to harvest the fruit, but with guidance, training and during special public events, such as an Apple Day.
- **New community orchard** – A suitable site is identified for creating a new community orchard, often on public open spaces managed by urban local authorities or as part of new housing developments.
- **Rescued community orchard** – Old abandoned or neglected orchards are restored by negotiating with the owners, arranging a legal lease, licence or tenancy agreement, clearing scrub and restorative pruning and mowing.
- **Membership orchard** – Members may pay a membership fee. They then have rights to the harvest but also the responsibility to manage the trees and orchard.
- **Allotment garden orchard** – Members of the allotment may have mandatory work party days.
- **Community Supported Agricultural (CSA) orchard** – There are several different CSA models. Members may pay for a regular delivery, have mandatory work days, and shared ownership etc.
- **Permaculture orchard and food forest** - Some groups are integrating permaculture concepts into their orchards by creating food forests that interplant various types of perennial food crops. The goal is to create an ecosystem that works in harmony with nature. In food or edible forests, trees, shrubs, and herbs work together to prevent pest and disease problems and to increase soil fertility.
- **Compensation orchard** – Land may be offered as a legal or informal compensation for some land development, such as housing or road building eg. in the UK this might be through Biodiversity Net Gain agreements.

Community orchards

Community orchards are created by and for local people. These were obviously developed in many Eastern European countries during their communist periods. More recently the idea for community orchards was popularised in the US in the 1980s and then developed in a few European countries for example by Common Ground in the UK. There are now many community orchards in most European countries. Some are completely owned and run by the community, some by local authorities with local people.

Pick Your (City) Fruit is a project in Lisbon, Portugal supported by the European Cultural Foundation. Their goal is to create public orchards that will be cared for by the community and will also be a place where all members of society can share "experiences, techniques, recipes and food".

The traditional orchard offers a landscape of tall trees changing with the seasons, fruit of many kinds, good soil and an array of wildlife. A community orchard adds to that rich mix, a place to learn and exchange knowledge, to hold festivals or seek quiet contemplation, a place for social play and work and somewhere to explore and show off how to live well with nature. Community orchards can be set up almost anywhere – on or near school grounds, in hospitals grounds, around residential care homes, on council land or land around social housing, on town greens, on derelict sites, alongside paths and on the edge of forests, as well as on allotments and open ground.

The characteristics of traditional orchards suit community ownership, volunteer management and wide public use.

Traditional orchards and community orchards are similar in many ways:

- **a group of fruit and nut trees** – often many different species and old local varieties of varying age providing a varied landscape and a long harvest season.
- **Often grown on vigorous rootstocks** - with long-lived trees up to 100 years old on tall trunks so grazing livestock or mowing machines can go under the trees and people can picnic and play.
- **at low density** – sometimes interplanted with other crops between rows.
- **in permanent grassland** – mown, often for hay, or grazed by livestock.
- **managed in a low intensity way** – with little or no chemical input, some restorative pruning and often dead or decaying wood. So no risks from agrochemicals and low maintenance by volunteers.
- **for multiple products** - for volunteers and members to learn about and process at small scale.

6 Fundraising and grants

- **Purpose** - Funds could be raised for planning, planting and restoring an orchard, organising courses and workshops, having events in an orchard, processing and marketing fruit, advertising and promoting the work of the group, and producing publications and guides.
- **Timing** - It may take up to 6 months for any funds to be granted after an application. So it may be best to send applications to two or more funders as offers can always be reduced or rejected.
- **Funding criteria** - But for all of these funding sources it is always best to identify the need, and if possible quantify with evidence. This can be matched with the funder's criteria.

Typical funding application sections

- What need? - with social, economic and environmental evidence.
- Why this funder? - The link to their criteria.
- What for? - aim and SMART objectives (specific, measurable, achievable, realistic and time-related).
- Who for? - clearly, and even quantitatively, identified.
- Who by? - staff, workers, volunteers and community.
- How? - The timed and staged process, linked back to each objective and the results.
- How judged? - the way success of the project has been evaluated.
- What result? - tangible outputs and longer-term outcomes, both product and process.

Opportunities with EU funding

- There are several opportunities for funding from the EU including Erasmus +, which funded this CORE Project, LIFE, INTERREG, LEADER and ERDF. These can be supplemented by regional government or charitable grants.
- Funding opportunities also exist with crowdsourcing, donations and loans, lottery, charitable and non-governmental funding,

7 Routes to learning

Learning from other orchardists

Smallholders and farmers are the traditional orchardists of traditional orchards. However farmers with old orchards on their land may often be reluctant to talk to staff from non-governmental organisations or local authorities. Their suspicion is that these organisations may wish to control the management and future of their orchard.

So an empathetic approach is needed when visiting the orchard of a smallholder or farmer.

- Orchard owners can be very proud of their history and may just need someone to take an interest. The ability to listen with interest and allow the owner to do most of the talking is essential.
- Conversations can include the varieties, the age of the trees and orchard, who planted them and what was done with the fruit.
- It is important to enthuse about the history of the orchard and how previous generations managed the orchard. It is also important to empathise about the need to generate some funding from the orchard.
- Examples of how other farmers have developed multiple uses of the orchard and diversified with processed orchard products, ecotourism or Government funding. Offers can be made of funded pruning workshops, grants for tree planting. Having a knowledge of grants and uses for the fruit available is also helpful.

Learning from others

- Trainers at workshops eg. for grafting or pruning.

- Volunteer leaders during seasonal activities eg. as a small pruning team in summer or winter, scything with a demonstrator.
- Guides, manuals, websites and videos.
- **Trainers** – Learning how to train others about traditionally managed orchards.
- **Orchardists and farmers** - Learning about open days and visits to their orchards.
- **Food and drink processors** - Learning about harvesting, preserving, processing and marketing.
- **Peers** - Learning across regions, countries, networks and partnerships. The communication can be in regular or annual meetings and events or online. The CORE project partners are all part of different networks and partnerships eg. Europom, Orchard Network UK, Carpathian Basin Orchard Group.

Sites for learning

- **Practical learning in the orchard** - eg. about planning and planting an orchard.
- **Practical learning at events**- eg. about processing and marketing at a fruit pressing event.
- **Online and book learning** – eg. about the heritage of orchards and varieties, through websites and videos.

8 Know the learners

Teachers are also facilitators which means they follow as well as lead learners. They learn about and from participants as well as enable participants to learn.

One of the most important aspects of training is to know your audience. Knowing your target learner will help you know how to design your teaching and also who to invite to the course.

What to learn about the learners

- **Demographics** (eg. age, sex, where they work) - This will help with logistics of the teaching as well as for planning the examples to use.
- **Knowledge** - Knowing the in-coming knowledge level of the topic will help determine what level of content is needed and what type of activities are needed.
- **Skills** - It is important to know the technical skill level of the participants. It will help determine if the teaching is to provide new skills or simply a refresher to skills the participants already know.
- **Attitudes** - Knowing what the attitudes are about the topic can help address fears, concerns or biases.
- **Experience** - Knowing the experience level of the participants will help when designing the content and activities. In addition, it will help if you can identify those people who have a lot of experience and can contribute to the discussions. Also for activities you can pair-up participants who have a lot of experience with those who have less experience.

- **Job/position** - Knowing the jobs or positions that the participants have will help you relate the teaching to their jobs.
- **Education** - Knowing the education level and also the type of education of the participants can help you know what level of language to use, as well as what type of examples to use.
- **Learning needs** – Asking the participants what they need and expect from the teaching is always a good start to any session.

How to learn about the learners

There are many ways to learn about the participants.

- Ask participants to complete a form to cover the above items and assess their learning needs, ideally sending it to the teacher before the session.
- Ask participants about themselves at the start of the session as part of the welcome and introductions.
- During the session repeatedly ask the participants about their experience, knowledge and skills.

9 Some learning principles

Adults learn differently from children and require different teaching approaches. Knowing how adults learn is critical to the success of your teaching. The following describes some important adult learning principles and teaching techniques you can use to engage adult learners.

Tips for educators

- **Sharing** - Adults bring a wealth of knowledge and experience and they want to share their knowledge and experience. So encourage participants to share their knowledge and experiences. Include activities that use their knowledge and experience.
- **Active participation** - Adults want to actively participate rather than just listen to a lecture. So create a participatory learning environment with various types of activities. If a trainer only lectures then participants will probably only remember 20% of what is said. So creating participatory training where participants are active. “Saying and doing” will help them remember more from the session.
- **Problem solvers** - Adults are decision-makers and self-directed learners. So include problem-solving activities.
- **Relevance to tasks** - Adults are motivated by information or tasks that are meaningful and applicable to their interests and work. So relate the content and skills to the life and work of the participants.
- **Relevance to world** - Adults prefer learning that focuses on real life problems. So relate content to the types of problems they encounter and the world around them.
- **Useful time** - Adults expect their time during a learning session to be used carefully. So follow a realistic time schedule.
- **Embarrassment** - Adults feel anxious if participating in a group makes them look uninformed, either professionally or personally. So avoid criticism and acknowledge all participant contributions.

- **Positive respect** - Adults learn best in a positive environment where they feel respected and confident. So create a positive environment by provide positive feedback and showing respect to all participants.
- **Respect** - Adults come from different cultures, lifestyles, religious preferences, genders, and ages. So respect all differences and encourage participants to respect each other's differences as well.
- **Questioning** - Engage the participants by using questions to engage participants and determine their level of understanding.
- **Communication** - Communicate effectively with facial expression, voice, eyes, ears, hands, feet, mind, and heart.
- **Repetition** - Use repetition to encourage remembering. For people to actually learn something they sometimes have to hear it several times. So repeat in the introduction (what they will learn), the presentation (what they are learning), and the summary (what they have learned). Less content with more repetition may mean more learning.
- **Learning styles** - Adults have different learning styles that must be respected. So provide multiple ways for participants to learn the material.

Basic learning styles

In addition to principles of adult learning there are three basic learning styles.

- **Visual** - Learn through watching, observing, and reading - I see and I remember. Some people learn primarily when they only see someone do an activity or they can see visuals and printed materials.
- **Auditory** - Learn through hearing - I hear and I forget. Some people learn (and remember their learning) primarily by hearing others talk.
- **Kinaesthetic** - Learn through moving, doing, practicing and touching - I do and I understand. Some people learn by moving and doing.

Most people use all three styles, but usually have a dominant or preferable style. The learning style that people use also depends on the skills and knowledge that are being taught.

So how should you plan your teaching session with all these points in mind? The aim is not to focus on one style of learning but to use a blend of methods to reach the greatest number of adult learners.

Examples in an orchard - Demonstration, guided practice, discussion, quiz, self-guided trail, map, photo guide, QR code labels.

Examples in a teaching room - Lecture, presentation, discussion, activity (eg. quiz, brainstorm), video, manual, handout.

Work singly, in pairs, as group. Invite external presenter.

Preparation for teaching

- Know what you are teaching
- Use effective organisation skills
- Prepare the meeting place, site visit and teaching room
- Plan teaching time
- Prepare for difficult participants
- Prepare for difficult locations and facilities, weather
- Prepare equipment and materials
- Practice
- Have a backup plan

10 Protecting people and plants

Health, safety and environment

Health and safety is now closely integrated with good, responsible environmental management. Many large businesses now have an integrated policy for health, safety and the environment. This can also include biosecurity – maintaining the health of the orchard trees so they are free of introduced pests and diseases.

Biosecurity – cleaning tools, clothing

With global trade and travel, there is increasing risk of introducing pathogens from other countries to orchards. So biosecurity is an important and responsible consideration. Infections can be transmitted from footwear, clothing and particularly secateurs and saws. Iso-propyl alcohol on a cloth is the best way to clean tools so they are not introducing pathogens from other orchards or trees.

Health and safety onsite

Many orchard owners and community groups produce a Health, Safety and Environment policy which is reviewed and possibly revised annually.

- **Entrance** - Considerations of health and safety in the orchard start at the entrance. Tools and equipment taken into an orchard should be safe and clean to use.
- **Insurance** - In a community orchard volunteers may not be insured to use power tools or ladders, even if they have qualifications and safety equipment.
- **Ladders** - Long-handled saws and pickers or sheets and a beating stick may be good and safer alternatives to a ladder.
- **Clothing** - Protective glasses, gloves and hard hats are standard protection from falling limbs and sawdust.
- **Bonfires** - Small brushwood piles or barriers round the edge of the orchard may be healthier, safer and more climate-friendly alternatives to bonfires of pruned branches.
- **Policy** - Some community orchard groups have policies that include lone working, use of agrochemicals, availability of a first aid box and a qualified first aider, the public display of the policy, as well as the points above.

Health and safety off-site

The processing of orchard fruit often involves electrical machines, cutting blades, heat and other potential hazards. All these need to be carefully considered for their degree of risk and ways of minimising it.

Risk assessment

Risk assessments could be written and publicly available for a range of locations and community or volunteer activities, such as planting, pruning, pressing, grafting and harvesting. As a requirement of their insurance for public liability they may also produce a risk assessment for each group and learning session such as grafting, pruning or processing.

The risk assessment could list:

- The responsible person
- Hazard eg. use of grafting knife
- Persons at risk eg. trainee
- Probability – on a scale of 1-5
- Severity – on a scale of 1-5
- Means of risk reduction

Case Studies

- Certificate in Community Orcharding (UK)
- European Orchard Day (INT)
- Apple Day (UK)
- The UK Orchard Network (UK)
- Traditional Orchard school competition (PL)
- An Autumn fruit festival (HU)
- Well-being from the land course (HU)
- The Natural Orchard Pledge (UK)

Websites

- Protecting our Orchard Heritage - A good practice guide for managing orchard projects, Sustain
- Traditional Orchard Project – Peoples Trust for Endangered Species
- Orchard guides and advice - The Orchard Project
- Maintenance of traditional orchards in Germany - EC
- UK Orchard Network
- EU Farm to Fork Strategy - EC
- Potential future for orchards and agroforestry - Sustain

PDFs

- Community orchards case studies – Dept of Communities and Local Government
- Orchard year planner - – Peoples Trust for Endangered Species

- Streuobst in northern Europe
- Economic, biodiversity, resource protection and social values of orchards
- European weblinks – ESTO Project
- Orchard glossary – different EU languages – ESTO Project

Downloadable pdf files

- Natural England Technical Information Series - Download pdf files from the end of the long list
- Advice notes – Orchard
- Traditional Orchards – A guide to wildlife and management. Peoples Trust for Endangered Species
- Starting up community orchards - Federation of City Farms and Community Gardens
- How to Guide to Setting up your own community orchard - Communities and Local Government Department
- Community Orchards Case Studies. Communities and Local Government Department

Videos

- Growing and using apples, Stamford Community Orchard Group
- Why an orchard is a magical place – Gloucestershire Orchard Trust
- Conserving the diversity of apples in Europe - ECPGR
- Modern apple orchard and pickers – Roche Farms USA
- The variety and origin of apples – Wild apple – Antje Majewski
- Planning your own community orchard – Brighton Permaculture
- Apple trees for cities – Antje Majewski

Part 2 - Managing orchards with nature

Aim

To learn about the ecological approaches to managing traditional orchards.

Learning objectives

The learner should be able to know about, understand, describe and demonstrate:

- The basic principles of agroecology and permaculture for traditional orchards.
- The value of biodiversity for soil moisture, nutrients, pest and disease control.
- How to naturally manage grassland, scrub, soil and the canopy of orchards.
- How to naturally control fruit tree pests and diseases.
- How to choose plant associations and plan for companion planting in orchards.
- How to choose appropriate livestock and manage grazing in orchards.
- How to naturally propagate fruit trees.
- How to survey and monitor the biodiversity of a traditional orchard.

Optional learning approaches

Plan a visit to a biodiverse orchard at flowering and/or early fruiting time to describe, demonstrate, discuss and practice:

- Digging a hole as a soil profile to observe tree roots, worms and organic matter.
- Looking below the grass sward and mulches to detect soil properties, organic matter, temperature and moisture.
- Spotting vertical layers - ground, sward, shrub and tree, and any different layering around the orchard.
- Surveying, recording and monitoring the key plants, pollinators and pest controllers.
- Beating tree branches with a sheet under the branch to observe leaf and flower invertebrates.
- Using live traps (pitfall, sticky, moth and flat boards) to observe ground-living invertebrates and small vertebrates.
- Using a hand lens and identification keys to observe epiphytic lichens and mosses on the fruit trees.
- Using a hand lens on tree flowers, leaves and fruit to observe invertebrates as carnivores or vegetarians.
- Monitoring environmental changes (eg. for soil, water or light) and their effects.
- Observing and mapping any natural succession eg. from a hedge to grassland.
- Using recording sheets and maps to compare different orchards, tree species and layers.
- Exchanging experiences amongst participants.

1 Principles of managing with nature

The principles of an agroecological approach to managing orchards are often associated with permaculture principles. The permaculture orchard is a food forest ecosystem with vertical, horizontal and species diversity, where trees, shrubs and grassland plants work together to increase soil fertility and control pests and diseases. They combine food plants with non-food plants, and may include grazing livestock.

- **Know the ecology and landscape of the site and local area** - To know and work with existing conditions and not against them requires less effort and gives more from less. An orchard is not a stand of fruit trees, it is a semi-natural habitat, consisting of vertical layers of trees, shrubs, meadow, ground layer and soil as well as horizontal spaces that link to the local area.
- **Know the ecology of the fruit trees** - Link this to the ecology of the area. Select fruit trees that are more resistant to pests, disease and environmental stress.
- **Build a diverse, polyculture system** - Instead of a monoculture get closer to the balance found in natural ecosystems. Crops can also be in the sward (eg. daffodils, strawberries) as well as in the shrub layer (eg. blackcurrant, gooseberry) These are traditional intercrops in France and the UK.
- **Encourage diversity of age, structure and species** - This will ensure a resilient growing environment.
- **Use ecological regulation to promote growth** – Use natural insect predators and companion plants as pest controllers instead of using toxic agrochemicals which can be unhealthy for all living things.
- **Make the soil living and healthy** - The health of the fruit trees depends on meeting their nutritional needs through the soil and roots as well as the microclimate and environment around the leaves.
- **Use natural resources sustainably** – Minimise the environmental impact of using water, wood and energy. Conserve soil, water, biodiversity as well as local heritage fruit tree varieties. Use local resources to avoid distant transport.
- **Help natural cycles and systems to work** - Leave deadwood and other organic materials on site for the benefit of decomposing organisms.
- **Prevent rather than cure problems** - Sometimes doing nothing is the right thing to do eg. no pruning or clearing prunings.
- **Believe that each species has a benefit** - Understand the role of each species, including the so-called weeds and pests. Be sure that life is for your benefit.
- **Share the fruit crop with others** - Always leave some fruit for birds, insects, mammals and fungi as a way of increasing biodiversity.

2 Managing orchard grassland

The semi-natural orchard habitat contains elements of woodland, pasture, meadow grassland, is often bordered by hedgerows and can also include areas of scrub. These vegetation types add to the plant diversity and create a mosaic of habitats to support a vast range of species.

The community of fruit trees need these different vegetation types to be balanced and maintained in order to create the right microclimatic and ecological conditions for fruit production. So all these vegetation types need some level of management to maintain the health and productivity of the fruit trees. Without appropriate management of the grassland the grass sward will quickly develop into a dense thicket of scrub, swamping

the fruit trees. Each vegetation type requires different management.

The species composition and diversity of the grassland is very important in influencing the soil condition, availability of nutrients and water, presence of pollinators, as well as weed and pest control. So the orchard grassland has a huge influence on the growth and productivity of fruit trees.

Tips for mowing

- **Frequency** - This depends on the soil moisture, and hence rainfall, as well as on the species composition. Two or three mowings per year (eg. March, June and September) enable fruit to be picked from the recently mown ground as well as obtaining a useful hay harvest for mulching or feeding livestock. Depending on the preferred grassland species, it is important to decide if any summer mowing should be included or if species should be allowed to flower and seed. Generally more frequent mowing with removal of the cuttings has a more positive effect on species diversity. However different frequencies of mowing and removal usually have little effect on species diversity.
- **Grass collection** - Removing the mown grass and other species will eventually reduce the nutrient content of the soil and increase species diversity.
- **Pattern** - Periodic mowing of several small areas of an orchard maintains the structural diversity of the orchard by still providing wildlife areas for food and shelter. It may also preserve the varied microclimate of the orchard.
- **Tools** - Mowing machines can be used but are noisy, fuel hungry, soil compacting and difficult to handle with low branches and randomly spaced trees. Mowing by hand with a light, modern scythe can be done on successive days or periodically in small areas of the orchards. Using a scythe is quieter, physically healthier, easier to handle under low branches and more accurate to protect tree trunks than a mowing machine.

3 Managing orchard scrub

Some scrub is an essential part of a semi-natural orchard habitat by providing additional food sources and shelter from predators and severe weather, especially for birds, insect predators and pollinators. Mixed hedges (eg. hawthorn, hazel and myrobalan plum) can provide an ideal scrub habitat on the boundary of an orchard. The shaded ground under the scrub provides a more humid and cooler space than more open ground. This makes it a suitable habitat for many decomposing invertebrates and fungi as well as non-flowering plants. However scrub in the middle of the orchard may make mowing and harvesting fruit difficult.

Scrub at the boundary of the orchard can provide a gradual but continuous gradient (an ecocline) from the tall boundary trees to the orchard meadow. All semi-natural habitats have gradual ecoclines with no sharp borders between different vegetation types.

4 Managing orchard soil

In an unmanaged woodland leaves and branches annually fall to the floor in the autumn and continue the various biogeochemical cycles of carbon and nitrogen. At the same time the leaf litter and deadwood builds up the organic matter content, protects the soil from erosion, compaction and importantly the loss of moisture.

In a managed orchard the trees and plants also produce leaf litter and deadwood but less than in a woodland. These biogeochemical cycles are disrupted when the leaf litter, deadwood as well as grass cuttings or hay are removed to a compost or burnt. The health and diversity of the soil and biodiversity will only be retained if some leaf litter, deadwood and hay is retained in the orchard. Dead leaves and dried stems will provide a shelter of beneficial organisms over the winter. The less organic matter, the less humus and soil life. Fruit trees have to cope with more stressful conditions in soils that are less rich in nutrients and moisture. A drought stressed tree is also more susceptible to attacks from pests and disease.

Maintaining healthy orchard soil

- **Fruit tree guilds** - Use fruit tree guilds of the six different categories mentioned below. The mulchers and others provide a general covering that improves the microclimate and preserves moisture.
- **Root suckers** - A forest gardening approach encourages the vegetative reproduction of plums, damsons, cherries and quinces by making a dense scrub from the young root suckers.
- **Organic mulches** - Organic rather than synthetic mulches with a high proportion of small, dead woody material have a wide range of benefits.

Benefits of mulch

- It is a food source for many soil microorganisms.
- It adds organic matter to the soil which breaks down to form humus.
- It allows and retains water in the soil.
- It minimises evaporation.
- It regulates soil temperature, keeping it cool or warm enough for soil organisms.
- It controls and suppresses weeds.

- It prevents erosion and soil compaction.
- It provides a habitat for a range of invertebrates.
- It improves root volume.

Types of mulch

- Synthetic mulches such as plastic film and geotextiles interfere with gas exchanges between the soil and air. So these are inappropriate in a semi-natural orchard habitat.
- Organic mulches such as woody material, bark, woodchips, leaf litter or hay provide all the benefits mentioned above. Each organic mulch can be classified on the basis of the carbon-nitrogen ratio. The fastest decomposition is when the carbon-nitrogen ratio is 30 carbon to 1 nitrogen. Brown mulches of dead plant material have more carbon than this and green mulches of living plant material have less. Decomposition of brown mulch is slower than green mulch which is prone to anaerobic rot.

Woody material is an ideal mulch for fruit trees, as most wild fruit trees come from woodland edges. The decomposition of deadwood in a woodland is mainly by fungi as they break down lignin. Woodland soils are dominated by fungi. For fruit trees, it is best to mimic woodland soil and use bark or wood chips as mulch. Because they have a high carbon content, they decompose slowly and protect the soil for a long time. In a woodland soil the ratio of fungi to bacteria can be 100:1. Where the dominant vegetation is leafy, the bacteria dominate as they can break down the cellulose more easily.

Tips for applying mulch

- **Thickness** - Brown mulch materials should not exceed 10-15 cm thickness.
- **Mix** - Use mulch made of brown and green materials with an optimal carbon-nitrogen ratio if the aim is to improve soil quality. It should not exceed 20 cm thickness.
- **Suitability** - Only mulch the top surface of uncompacted, moist and unfrozen soil. Compacted soil can block air and moisture from reaching the tree's roots.
- **Tree trunk** - Keep the mulch 15-20 cm away from the trunk to avoid rot-causing moisture and to avoid giving shelter to rodents and other pests.
- **Tree canopy** - The mulched area should extend beyond the edge of the tree's canopy.
- **Tree roots** - As the tree grows, the mulched area should be widened by 30 cm per year to give way to the development of new lateral roots.

- **Cardboard** - Beware that cardboard under the mulch takes a long time to break down.

5 Managing the orchard canopy

Canopy management of a tree often means pruning. Most orchardists consider pruning unavoidable, others limit it to the most necessary interventions, while there are some who are completely anti-pruning.

Advantages of pruning

- **Shape and size** - Pruning can develop the desired shape and size of the tree by creating and maintaining a balanced shape.
- **Fruit and shoot growth** - Pruning can adjust the balance of fruit and shoot growth. Trees use the energy from photosynthesis to grow both vegetative and reproductive material. The orchardist manipulates the distribution of energy by pruning, seeking to strike a balance between the two types of growth. If the growth of the vegetative material is strong, there will be less fruit. Generally, annual growth of about 50 cm is considered favourable. Fruiting should be prevented in young trees of up to 3 years old by removing blossom.
- **Light and air** - Pruning can let sunlight and airflow inside the tree by thinning the internal branches. Without pruning fruits will appear at the ends of the branch and the weight will pull down and possibly break off the branches.
- **Dead branches** - Pruning can remove dead or diseased branches.

Disadvantages of pruning

- **Nutrients** - Pruning removes significant capacity for nutrient production resulting in less nutrient uptake and carbohydrate production.
- **Infection** - Pruning creates cuts with potential openings for fungal and other infections.
- **Plant hormones** – Fruit tree growth is both promoted and inhibited by plant hormone. They are continuously produced at some points on the tree and then relocated to where they are needed. Pruning disrupts this flow.
- **Root shoot balance** - The invisible consequence of pruning is a loss of root mass, as the root does not receive sufficient primary metabolite due to the reduced photosynthetic surface. Some of the roots die back and are infected by saprophytic fungi. This affects the stability of the tree.

Recognising the environmental factors

Pruning will only affect the internal conditions of the trees. However the external environmental conditions also considerably affect the management and growth of the canopy. Other neighbouring trees, shrubs and plants will be competing for light, nutrients and water as well as being linked through the wood wide web of mycorrhizal fungi in the orchard soil. So in order to manage with nature it is important to select fruit trees for that particular location. Then its whole environment can be minimally managed rather than just its branches.

Balancing growth

Removing blossom from young fruit trees encourages the vegetative growth of shoots. However, rapid growth can create a leggy, loose structure which is less resistant to wind damage and pests. Trees will strive for a balance typical of their age in the growth of their vegetative and reproductive material. In unmanaged woodlands the environmental factors determine the balance of growth in shoots or fruits.

6 Natural pest and disease control

Pests and diseases are part of the natural ecological system where there is a balance between predators and pests. This is nature's way of controlling populations. The creatures that we call pests and the organisms that cause disease only become 'pest and diseases' when their activities start to damage crops and affect yields. If the natural ecological system is imbalanced then one population can become dominant because it is not being preyed upon.

The aim of natural control is to restore a balance between pest and predator and to keep pests and diseases down to an acceptable level. It is not to eradicate them altogether, as they also have a role to play in the natural ecological system.

Tips for natural control

- **Identifying the problem** - The problem may be caused by a pest or disease but may also be caused by a mineral deficiency in the soil or an environmental factor. So proper identification should be the first step in controlling the problem and, more importantly, in preventing it from happening again.
- **Healthy soil** - A soil managed using organic methods, especially using mulch and compost, will give fruit trees a balanced food supply. Trees which are fed well, like people, will be much more resistant to pest and disease.
- **Appropriate tree** - A fruit tree growing in a soil, microclimate and environment where it is not suited is more likely to be attacked. The right choice of fruit tree species and variety will help to deter pests and disease.
- **Genetically diverse trees** - Fruit tree varieties each have their own unique set of genes (genotype) able to resist a wide range of pests, diseases and environmental conditions such as drought or flood. Older heritage varieties are a source of genetic diversity which may often have wider resistance to pests and diseases than modern varieties.
- **Hygiene** - If infected plant material, live or dead, is left lying around, pests and diseases may be passed on in following years. However there may be some evidence that the removal of plant material prevents the development of disease resistance.
- **Companion planting** - Certain plants can protect fruit trees from pests or diseases, often through their secondary metabolite chemicals called allelochemicals.

Other controls may be included as organic controls. However they are not truly natural controls. They may include:

- **Traps** - using bait, sticky material around the trunk, light and pheromone traps.
- **Biological control** - introducing one organism to control the pest.

- **Natural pesticides** - - using garlic, chilli, marigold and vinegar sprays.

Ecological regulation

Pests, such as some insects and fungi, are present in nature. However where there is a diversity of habitats and species their numbers are usually moderate due to ecological limits imposed by this diversity. Pests can be naturally controlled by:

- **Natural predators** – For example the enemies of aphids include predatory ladybirds, lacewing and hoverfly larvae, crab spiders, parasitic wasps and pathogenic fungi.

- **Allelochemicals** – Secondary metabolites are produced as natural chemical defences by the roots, leaves and other parts of fruit trees.

- **Nearby plants** - In an environment with high biological diversity, there will be a number of plants near the fruit trees which also produce allelochemicals in the roots and leaves.

As a result of this ecological regulation, pest damage to the tree is not lethal. Due to the decrease in photosynthetic activity, the growth of shoots are moderate.

Effect of pruning

Pruning decreases the photosynthetic surface, and forms a wound as a point of potential fungal or bacterial infection. To compensate for the pruned branches, wood is forced to produce primary metabolites and has less energy to defend itself. This can cause a vicious circle of pruning to disease to pruning etc.

Ecological control of pests

From an ecological point of view, pests can sustain a diversified food chain which can sustain biodiversity. Managing with nature balances the population of pests by encouraging a diversity of species.

Defence from diversity - Each part of the tree, its roots (rhizosphere), trunk, leaves (phylosphere), has billions of coexisting microorganisms whose species diversity is innumerable. All chemical interventions degrade this micro-community, reducing species diversity and multiplicity. This cohesive micro-community is the number one line of defence for tree health and regulates admission to that community.

Agrochemicals - Persistent chemical treatments, in addition to leading to the development of resistance in target organisms, degrades diversity and destroys this number one line of defence.

Siting to reduce pests - It is important to consider the ecologically optimum environment for each species of fruit tree. For example an eastern exposure may be beneficial because the rising sun quickly dries the dew, preventing favourable conditions for fungi.

Leaf fall - The leaf of the tree is part of its own self-sustaining cycle or the circular economy of the fruit tree. Without leaf fall, many soil-dwelling organisms will starve and biodiversity will again be reduced. Mixed forest leaf litter provides a habitat for the pest controllers such as predatory insects and small mammals.

Ecological regulation - This is the plant protection for managing with nature. It depends on the biodiversity and environment around the fruit tree. The poorer the species diversity means the poorer the pest control.

7 Companion planting

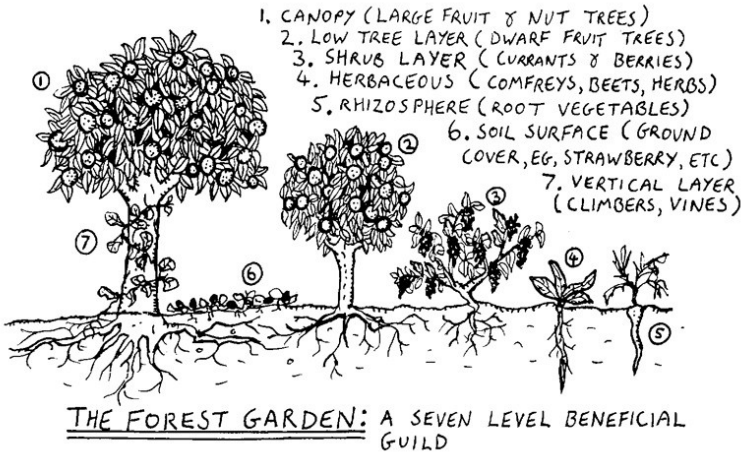
In a natural ecosystem trees and other plants are continually interacting between species and individual plants as well as continually responding to their microclimate. Natural ecosystems are self-supporting and balanced, due to their high age, structural and species diversity. It is possible to create healthy and productive orchards by copying this diversity of natural ecosystems and respecting the interactions and responses of the fruit trees and surrounding plants.

Fruit tree guilds

Fruit tree guilds are one of the permaculture design techniques. Guilds are human-made planting systems around trees with each plant providing particular services to the fruit tree. Planting a fruit tree guild is not appropriate in am established semi-natural traditional orchard where native species are natural fixers, mulchers, attractors, repellers, suppressors and dynamic accumulators. Fruit tree guilds are more suitable when creating a new small orchard.

Fruit tree guilds are typically made up of plants in six categories:

- **Dynamic accumulators** are deep rooted and bring nutrients up to the soil surface eg. alfalfa, comfrey, lemon balm, mustard, nettle.
- **Attractors** attract pollinators and beneficial insects eg. chamomile, mints, comfrey, lavender.
- **Fixers** fix nitrogen by hosting Rhizobium bacteria that convert nitrogen from the air and store it in root nodules. The nitrogen becomes available to the fruit trees as the fixer decomposes eg. legumes such as beans, clover, lupin, vetch.
- **Mulchers/compost makers** create a significant amount of organic matter and help improve the soil condition, preventing soil compaction and erosion, reducing weeds, saving soil moisture, and boosting soil biodiversity eg. comfrey, jerusalem artichoke, rhubarb.
- **Suppressors** suppress weed growth by covering the ground and shade and out-compete weeds eg. pumpkin, strawberry, mint.
- **Repellers** repel unwanted pests from the fruit trees by their allelochemicals and scent, but may also repel beneficial insects eg. daffodil, garlic, lemon balm, marigold.



THE FOREST GARDEN: A SEVEN LEVEL BENEFICIAL GUILD

Tips for creating guilds

- Create the seven vertical layers from the canopy to the soil surface.
- Guilds can include plants in any category and in any position.
- Plants can be selected according to the ecology and microclimate of the site.

- Some plants serve more than one purpose in the guild eg. Comfrey is an excellent mulcher but also attracts pollinators when in flower.
- Select perennials and self seeding plants species for easy continuity.
- Avoid planting poisonous and edible plants in the same area.
- The composition of the guild can be changed as the trees mature and conditions change.
- Plan the plant selection and location based on the future growth and shade of each fruit tree.
- At the outer edge, along the drip-line grass suppressing bulbs such as daffodils can be planted to stop grass moving into the guild. Inside the drip-line mulchers, accumulators, attractors, repellents, fixers can be mixed.

8 Grazing livestock in orchards

Ground cover must be managed in orchards for their health and productivity. Excess ground cover competes with trees for water and nutrients.

- Orchard trees planted in traditional wide-spaced patterns are well suited to targeted grazing.
- Sheep, goats and other livestock have been used for centuries to graze orchard understory vegetation. Actively growing grass and weeds can have high forage value for livestock.
- Orchard grazing requires fencing, access to water, and a secure holding area.
- Livestock must be monitored carefully to avoid overgrazing or browsing.
- The number of animals needed for targeted grazing fluctuates during the growing season.
- Collaboration with other orchard growers can allow targeted grazing.
- Livestock should be removed when the orchard is wet.

The orchards will inevitably be visited by various wild grazing species, such as voles, rabbits, deer and wild boar. They are attracted not only by grazing, but rather by the possibility of obtaining food in winter and spring, when the tasty bark and sweet sap of young unprotected fruit trees offers food. These wild grazers can be seen as pests but, viewed more holistically, these can also graze grass and shrubs and fertilise the soil.

Like wild animals, domesticated grazing animals can cause both harm and benefit.

Pros of livestock grazing

- Reduces orchard mowing as well as equipment and labour costs
- Improves nutrient, water and microbiological cycling.
- Produce faeces.
- Provides additional income.
- Controls grass and legume weeds.
- Maintains air flow through the trees.
- Controls scab by grazing leaves and suckers.

- Clears fallen fruit.
- **Goats** - Clear scrub and young trees.
- **Pigs** - Reduce persistent root weeds, clear all vegetation and clean up rotting windfall fruit.
- **Geese and ducks** - Mow grass short, and control breeding cycle of pest insects.
- **Chickens** - Control breeding cycle of pest insects.

Cons of livestock grazing

- Needs food, water and shelter.
- Decreases biodiversity by selective grazing.
- Compacts and enriches soil.
- Needs fencing and handling.
- **Cattle and horses** - Browse lower branches, rub against trees and strip bark from trunks so need strong tree guards.
- **Sheep**, esp. primitive and hill breeds - Eat buds and leaves below 1 m, debarks trunk and lower branches, esp. in late winter when limited forage and sap flows, and shelter under trees in groups.
- **Goats** - Debark and kill most orchard trees and may climb tree and prune canopy.
- **Pigs** - Damage tree roots.
- **Geese, Ducks** - Need protection from predators, may need strip grazing and extra fencing, may make noise, and need small pond for preening and bathing.
- **Chickens** - Need protection from predators, may need strip grazing and extra fencing.

Environmental factors

Many environmental factors can influence the effect of grazing on the productivity and biodiversity of the orchard - its location (topography and exposure), climate (including microclimate) soil (type, condition and moisture) and vegetation.

An orchard like an ecosystem has ecological resilience as it can respond to disturbance from grazers and recover quickly. But this disturbance can be influenced by several factors:

- The livestock species or breed.
- The number of livestock.
- The time and season of grazing.

Impacts of grazing

Excess nitrogen - Numerous studies claim that grazing improves the nutrient, water, and microbiological cycles in the orchard as a result of animal faeces, and that the fertilizing

effect of animal faeces increases the nitrogen supply and yield of trees. However an excessive supply of nutrients only enhances the vegetative functions of the tree with a lower fruit yield.

Animal faeces are rich in nitrogen, especially urine. This excess nitrogen requires carbon, as microorganisms that decompose organic matter use 30 units of carbon per unit of nitrogen. Sources of carbon can be fibrous humus-forming matter - fallen leaves from trees, dry branches falling from trees, and dried legume vegetation.

Without this carbon the nitrogen is either released into the air in the form of ammonia, or organic nitrogen compounds are released into the soil, where they decompose in the nitrogen cycle. Excess nitrogen binds either in groundwater, such as nitrite or nitrate, or in the air, such as nitrogen gas or nitrous oxide, putting a strain on the environment.

Humus - Grazing reduces the chance of residual organic matter accumulating on the soil surface. This is especially common when grazing completely strips the area. However grazing can contribute to soil development if it leaves a significant part of the vegetation in place and becomes a source of carbon that, together with the nitrogen from the faeces, increases the humus wealth of the soil.

Dung decomposers - Animal faeces or dung is an important source of nutrients. For these to be unlocked and available for plant growth, dung must be incorporated into the soil. Fungi, bacteria and weathering play a part in dung decomposition but a suite of invertebrates including flies, worms and beetles play a major role. The value of livestock faeces in an orchard depends largely on the presence and number of beetles. There are many beetle species that feed on faeces eg. about 60 species in the UK.

Controlled and targeted grazing - This involves livestock grazing all or part of the orchard for a short time until about half the green mass has been grazed. Temporary or electric fencing or tethering of livestock can be used for short-term grazing of targeted parts of the orchard. It may offer much more favourable opportunities for targeted grazing if orchard owners develop their grazing strategy together, involving the owners of neighbouring pastures.

9 Natural propagation of fruit trees

The reproduction of different fruit tree species can be sexual and/or asexual.

- Sexual reproduction by seed germination provides genetic diversity in preparation for the challenges of a changing environment. The continuous production of new varieties prepares the diversity from which selection finds the best form for adaptation.
- Vegetative reproduction by roots and shoots maintains the proven characteristics of the fruit tree adapted to its existing environment.

Different species have different reproduction strategies:

- Species that create solitary, free-standing trees with cross or self pollination, such as pear, apple, apricot, peach and almond. These species have a taproot system adapted to their more isolated position in terms of wind, sunlight and microclimate.
- Species associated with individuals of other tree species, such as cherry, rowan and walnuts.
- Species that produce clonal suckers from the roots or base of the trunk such as quince, sour cherry, plum (including damsons, gages and bullaces) and hazelnut. These species have a shallow root system adapted to their more clustered, social and shaded position.

Natural vegetative asexual reproduction

The most common case of vegetative propagation is propagation from root suckers. The parent clones itself with root shoots, which have no tap root. The trees are protected from wind blow by growing close together. They protect the soil moisture and create a favourable microclimate. These shared roots supply nutrients and even communicate chemically between trees as part of the wood wide web. With older trees an ectomycorrhiza network (a symbiotic association between a fungus and plant root) will also develop, which will also support the wood wide web. There are benefits from this protection and network which may compensate for the greater shade of neighbouring trees. These benefits can be seen, for example, in plums when some root suckers are chewed by rabbits. The community strategy for plums is to respond by producing seed.

Some fruit trees, such as quince, elderberry, fig and mulberry, can be easily propagated vegetatively by hardwood cuttings. They may also naturally produce roots from low growing branches that touch the soil.

Natural sexual reproduction

Growing fruit trees from seed produces the genetic diversity that plant breeders use for developing new varieties by selecting particular characteristics of the tree's growth, its fruit or its resistance to pests and diseases.

Over the last 2,000 or more years people have grown fruit trees from seed. Pome fruit seed (apple, pear and quince) germinates quickly after a period of several months in a fridge. Stone fruit is more difficult to germinate. Nut trees can be fruitful when grown from seed. Fruit and nut tree seedlings are now more usually used as rootstock for grafting known varieties.

- **As rootstock** -The seedlings can be used as rootstock to produce large standard trees.
- **As basis for processing** - Apple trees have also been grown from seed when it is accepted that the fruit may be very varied such as for processing as cider. With extensive space it may be worth taking the risk of producing a varied population of fruit trees. Some of the varied fruit may be useful for processing as juice or other products, as Johnny Appleseed promoted in the pioneering days of the US.
- **As potential new cultivars** - Some of the seed-produced fruit trees may be worth promoting and vegetatively propagating as useful new cultivars. Wildings are apple and pear trees naturally germinated from the seeds of discarded fruit. Some wildings have been propagated as new cultivars.

Case studies

- Scything in Orchards Workshop (UK)
- The Natural Orchard Pledge (UK)

Websites

- Forest Garden Training Center
- The Forest Garden solution – Trees for the Future
- Enhancing biodiversity in traditional fruit orchards - ResearchGate
- Orchards and biodiversity - UK Orchard Network

Downloadable pdf files

- Successful biological orcharding – Purdue University
- Benefits of non-cropping trees in orchards - Woodland Trust
- Orchards and wildlife - Natural England
- Perennial flower strips for pest control in orchards- Agricology
- Biodiversity studies of six traditional orchards – Natural England
- Natural pest and disease control - HDRA
- Opal Orchard biodiversity survey - OPAL
- Key challenges of orchard grazing – Agroforestry Innovation
- Holistic planned grazing: Sheep in orchards – Permaculture Magazine
- Survey of orchard pesticide use in the UK- DEFRA

Videos

- Successful biological orcharding Parts 1-12 – Living Web Farms
- Holistic orchard management– Living Web Farms
- Value and management of veteran fruit trees – VETree Project
- The biodiversity value of an orchard – Gloucestershire Orchard Trust

Part 3 - Planning and setting up a traditional orchard

Aim

To learn about planning, creating and managing a new orchard and developing management plans for both new and neglected orchards.

Objectives

The learner should be able to know about, understand, describe and demonstrate (in the context of their local area and country):

- How to choose the site with personal, social and economic considerations (its purpose and value) and practical considerations (soil, climate, water, access, parking, pests, boundary and volunteers/ staff etc).
- How to choose the right tree species, varieties and rootstocks for different sites and uses.
- How to plan the right planting details (timing, spacing, tree size, protection and mulching).
- What resources are needed (trees, tree guards, boundaries, equipment, protective clothing and volunteer/ staff help).
- How to plant and establish new fruit and nut trees, with mulch, tree guards and formative pruning.
- How to restore a neglected orchard by restorative pruning.
- How and why to prune tip-bearing and spur-bearing trees differently.
- How to develop a seasonal management plan for the first few years of establishment and restoration (pruning, sward management, pest control etc.).

Optional learning approaches

Plan visits to a newly established and/or a neglected traditional orchard in the autumn to demonstrate, discuss, plan, design and practice in small groups:

- A plan for a new or neglected orchard over the next three years.
- The management in each season of a new or neglected orchard.
- The planting, protecting and mulching of new trees.
- The formative pruning of particular branches from 1-3 year old trees.
- The restorative pruning of particular branches.
- Exchanging experiences amongst participants.

1 Agreeing the purpose

The first step to planning a new traditional orchard must be to agree with all the stakeholders (including the family, community, volunteers or workers) the purpose or main aim of the orchard.

- **Multiple uses** – After five or so years a new orchard can have multiple uses, including fruit production, biodiversity, livestock production, education and leisure. It may be managed and used for these different purposes by a single owner/manager, a cooperative or a community.
- **Productive orchard** – The fruit trees may be commercially managed for sale to different markets or be domestically managed for family or community consumption. Multiple use for production can include grazing livestock like sheep or geese, or soft fruit like gooseberries or blackcurrants.
- **Organic orchard** – A traditional orchard can easily be managed without the use of herbicides, pesticides or artificial fertilisers. The diversity of species, varieties and wildlife enables a more ecological, cyclical balance between fruit trees, their nutrients and the species that consume fruit trees. See Guide 2.
- **Biodiverse orchard** – Orchards, when they are fully developed and mature, can be very important for wildlife providing a mosaic of habitats, including deadwood, and a diversity of insect, bird, plant and fungal species. See Guide 2.
- **Amenity orchard** – Traditional orchard can be idyllic places for social gatherings, picnics, traditional events and fairs. They are places where people can rest and appreciate the seasonal beauty of blossom, fruit and wildlife.
- **Community orchard** – These are increasingly popular in Western Europe and can combine all of the above functions. See Guide 1.
- **Agro-tourism orchard** – These have developed more in the south of Europe and may include camping and guided tours or tastings on the smallholding or farm.

2 Selecting a site

- **Locating possible sites** – Suitable sites for new orchards are often hard to find. Having seen land for sale a review of the online Google map and the suggestions of local people may be the best starting point. For community orchards local councillors or government officers may be approached to find public green spaces. It may also be worth asking private landowners of estates, farms, smallholdings or businesses about their landholdings.
- **Survey** – Fruit trees are site-specific so it is vital to explore and survey the possible sites.

- **Soil, water and sunshine** – All trees need soil, water and sunshine. So site selection for fruit trees is to a large degree determined by the quality of the soil and the moisture availability during the growing season. A well-drained sandy loam of sufficient depth is ideal. Fruit trees should be planted in full sunlight, without shade caused by buildings or other trees.
- **Vegetation** - Good pollination for many types of fruit is vital for regular crops. Without the help of pollinating insects, regular crop production is a frequent problem. Wild flower areas can help by providing a regular nectar supply for pollinators throughout the growing season. Also check any possible future shade from surrounding young trees.
- **Grazing animals** – Check what local wild animals, such as deer, rabbits, voles, could graze on the bark or leaves of young planted fruit trees. Tree guards are likely to be needed. If the aim is to graze the orchard with livestock, 4-post tree guards may be needed with a boundary fence and drinking water.
- **Boundary** – The boundary of an orchard was often traditionally planted with myrobalan plums as they are tall, easily grown from seed, can be used as rootstocks for many stone fruit, and are not a source of fruit tree aphids etc.
- **Microclimate** - Open sites without any protection against strong winds may be OK in the south of Europe. However in the north of Europe, where the temperatures are already lower and the winds even stronger, compared with the south, the trees may survive, but regular crops are unlikely to be achieved. Shelterbelts and windbreaks on the boundary can help. Valleys collect cold air and often lead to spring frosts at the time fruit trees are in blossom. The prospects of a decent crop diminish with every spring frost in the period from late March to the end of May. So plan to plant further up any slope, where the air is warmer.
- **Access and parking** – Good access for vehicles and people, an onsite source of water and car parking spaces may be important.
- **Stores and facilities** – A dry, cool store will be needed if one of the aims is to store harvested fruit over the winter. In urban areas reused metal containers that are screened with wood panels or espalier fruit trees may be a safe, vandal-proof store for expensive equipment.

3 Selecting the trees

The right choice of fruit tree species and their varieties is difficult when there are so many options. But the choice could last for up to 100 years so it is important. There are many factors to consider including the purpose of the orchard.

- **Species** – Traditional orchards have a range of species to suit the soil and microclimate, as well as to extend the harvesting season and diversify the orchard.
- **Variety** - Old, traditional varieties, especially of apples, pears and plums, are typical in traditional orchards but are less reliable annual croppers than many modern varieties. Cross-pollination can be assured when there are more than one variety of the same species that flower at the same time.
- **Uses** - Selecting the right species and varieties is especially based on how they will be stored and used as well as the preferred taste, possible products of the fruit and the local potential market. Species and varieties that ripen their fruit at different, rather than the same, times can enable efficient picking and processing.
- **Rootstock** – Traditional orchards usually have fruit trees on standard rootstocks so

there is a bare trunk and fruit that is out of the reach of grazing animals. This is especially if the orchard will also have grazing livestock when the trunks of apple and pear trees will be 2 m and of plums and cherries over 1.5 m.

- **Frost** - Species and varieties differ in their resistance to frost. So the tolerant ones can be planted in positions to protect the less tolerant trees. In low-lying depressions, not only trees may freeze during winter, but flowers may also be damaged by frosts. These low areas may also have the wettest soil and highest groundwater levels.
- **Disease** – Varieties also differ in their susceptibility to diseases such as apple scab.
- **Amenity** - The decorative value of fruit trees can also be included in the planting design especially in the orchard entrance or highly visible sites. These could include myrobalan plums and crab apples which provide early and extended blossoming.
- **Short-term trees** - To make better use of the orchard area in the first twenty or so years, temporary fruit trees on half-standard rootstock can be grown between the permanent trees. These can then be removed when the tree crowns of the standard trees are fully developed.

4 Planning the planting

When establishing a traditional orchard, it is worth knowing that:

- It will be used for much longer than a commercial orchard, up to 100 years.
- It can be established and managed at lower costs than a commercial orchard.
- It can be established in places of little use for commercial orchards or other crops.

Tips for planting

The human factor - Many local people may have considerable experience of growing fruit trees. So a little time spent seeking advice may avoid future mistakes appearing several years after planting. When planning an orchard it is also wise to think of and plan for the future time and commitment of the people who will manage the orchard.

Preparation - Building on the initial survey, the appropriate local varieties of fruit tree can be researched and either ordered or grafted. Sufficient volunteers or workers also need to be primed and available for both the planned planting date and the subsequent checking, watering and formative pruning.

Timing – Planting in the early winter in dry weather ensures good establishment of the root structure. Successional planting over several years produces a more balanced age structure and diversity in the orchard and ensures some continuity.

Tree size – The eventual size of fruit trees on standard or half standard rootstock can vary from pears of up to 15 m tall to quince trees of 6 m. So the spacing depends on the species as well as its rootstock. Some varieties of apple that are triploid, such as Bramley, will need more space than normal diploid apples.

Tree spacing - The spacing between fruit trees on standard rootstock can vary between pears (10 m), plums (5 m) and quinces (3 m). Faster growing and earlier fruiting trees on half standard rootstock could also be interplanted with standard trees.

Planting pattern - Planting in rows rather than randomly enables easier mowing by machine and sectional grazing, especially in the first few years. After that a few trees could be removed or planted to vary the structure if required. A quincunx planting pattern could include 10 - 15 m spacings of standard pome fruit trees (apples or pears) in a square with a half standard tree in the middle and half standard trees between the standard trees. Interplanting the fruit tree rows with soft fruit, such as gooseberry or blackcurrant, may also be another possible design.

Land and boundary - The land and its boundary may need some preparation such as mowing, clearing scrub, fencing, planting a boundary hedge, making easy access and providing onsite water.

Final design – This can be done as an annotated plan after analysing all the social, financial, horticultural, ecological and technical options. The social and financial considerations may be the most important.

- **Social options** - What's the human resource to manage the orchard and possibly process and market the products? What are the legal, health and safety requirements?
- **Financial options** – How can the land and equipment be purchased or rented? How can the trees by grafted and grown or bought? Would seasonal workers, volunteers, shareworkers or family and friends manage the orchard at the busy times, and how much would that cost in money or kind?
- **Horticultural** options - What's the number of trees of each species and variety? Where and how will they be planted and managed in the first few years? How can the trees be protected with tree guards or fencing, and possibly mulched if in a dry climate?
- **Ecological options** – How will the orchard affect the existing habitats and wildlife on the site? How can the orchard management improve the biodiversity value?
- **Technical options** – How and where can the tools, equipment and produce be stored? How can the site be easily accessed and watered?

5 Sites for different species

All fruit trees are affected by frosts in the winter and especially at spring blossom time. They also grow poorly on compact or loose as well as excessively moist or dry soils, or excessively acidic or alkaline soils, or where particular diseases are common. So planting away from frost hollows or depressions, doing soil tests and finding out about local plant diseases are important.

Apple

- **Soil** - Various soils are suitable for their cultivation, both sandy and loamy, except

soils that are too loose, with a high level of groundwater or very dry. Slightly acidic to neutral soils with a low level of groundwater are suitable.

- **Water** - In wet soils, apple trees are often infected by diseases such as canker, gangrene, scab and brown rot. In dry soils, on the other hand, trees grow poorly, the fruit is often small or falls before harvest.
- **Temperature -** Of all the species of fruit trees cultivated in a temperate climate, the apple tree is the easiest to grow in traditional orchards and the most resistant to frost. So apple trees can be planted in cold regions.

Pear

- **Soil** - The soil requirements of pears are greater than that of apple trees. Warm and deep soils with a low level of groundwater are suitable for pear trees. They grow well and bear fruit in slightly acidic to neutral (pH 6.5) soil.
- **Water** - Due to the deep root system, pear trees do not tolerate periodic flooding or changes in groundwater levels.
- **Temperature** - The pear tree is a more demanding species than the apple tree. It needs higher temperatures than apple trees in both winter and the growing season. In northern Europe the fruits of some late pear varieties may not reach full maturity. So, in relatively cool regions, trees of summer and autumn varieties should be planted. The trees of late varieties will only produce tasty fruit in such conditions if they are grown on a high trunk and low crown.
- **Note** - Strong winds during the flowering period significantly increase the risk of damage to flowers by frost. During the ripening period of the fruit, strong winds cause premature fruit drop and limit growth as the soil is dried.
- **Disease** – Some varieties are prone to the widespread occurrence of Pear leaf cluster cups, a fungal disease causing premature leaf fall.

Plum, including damson and gage

- **Soil** – It prefers deep, heavy clay loam, slightly acid-neural (pH 6-6.5) soils. They need warm, well-drained soils, rich in nutrients and water. Damson trees thrive in alkaline soil.
- **Water -** It tolerates a relatively high groundwater level.
- **Temperature** – It flowers in early Spring so susceptible to frosts. Avoid frost-hollows (low down on sloping ground).
- **Light** - Good sunlight on trees promotes the accumulation of sugars in the fruit, which improves their taste and processing value.
- **Note** - It is often traditionally planted on the edge of the orchard or separately outside the orchard as they are smaller trees than apples or pears.
- **Disease** - Viral plum pox disease, which caused premature leaf fall and infected and reddish discoloured fruit, has discouraged the planting of plum trees.

Medlar

- **Soil** – It is shallow rooted so can be grown in thin soils.
- **Water** - It prefers moist, well drained soil.
- **Temperature** - It prefers warm climates but is not prone to frost as it flower in late Spring.
- **Light** - It tolerates partial shade.

- **Note** - The branches should not be pruned as terminal flowers are produced.

Quince

- **Soil** - It is suited to most soils, but particularly those that are deep and relatively moist throughout the summer.
- **Water** – It needs well-drained soil to avoid waterlogging in winter. But it is one of the very few fruit trees that can cope with a relatively poorly drained site.
- **Temperature** – It needs a warm, sheltered site. It is susceptible to frost but because the flowers open in May it does not get frosted very often and the set is usually good.

Sweet cherry

- **Soil** - It grows well on fertile, warm, alkaline (pH 6.5-6.7) and nutrient-rich soils. Shallow, waterlogged soils are unsuitable. Deep clay soils are most suitable, where the tree may reach a height of 10 m. and a width of 8 m. and live up to 80 years. It grows vigorously so need high levels of nutrients.
- **Water** – They need good drainage.
- **Temperature** - It is the least resistant to frost of the fruit trees commonly grown in northern Europe. So avoid planting in frost-hollows or windy sites.
- **Light** - It needs good sunlight.

Sour cherry

- **Soil** - It grows well and bear fruit in almost all soils, although it is usually grown in light soils such as sandy loams.
- **Water** - The fruit may crack and be infected with fungal diseases in wet regions with excess moisture and heavy rainfall. It has deep roots, so it will cope with weaker, more sandy soils.
- **Temperature** – It grows well in cooler climates. It is resistant to frost and is less damaged by spring frosts compared to plums and sweet cherries.
- **Disease** - Varieties that are sensitive to cherry leaf spot may have premature leaf fall and weak growth.

Apricot

- **Soil** – It prefers loose, airy, neutral (pH 6.5-7.5) soils.
- **Water** – It needs well drained, moisture retentive soil. Ground water must not be higher than 200 cm. It also needs additional organic matter for moisture retention on light soils.
- **Temperature** - It tolerates warm summers, but has moderate tolerance to heat fluctuations. So protect it from cold winds and late frosts and avoid frost-hollows.
- **Light** – It needs full sunlight.

Peach and Nectarine

- **Soil** – It prefers deep, well-structured, medium to loose, slightly alkaline (pH 6.5 not less) soil. On more strongly alkaline soils, it can only be grown on the lime-tolerant bitter almond rootstock.
- **Water** - It does not tolerate groundwater. It has a medium water requirement.

- **Temperature** – It needs a warm aspect as it is frost-sensitive.
- **Light** – It needs full sunlight as it is extremely light-hungry (2000 sunny hours) so protect it from wind and position it facing south.

Almond

- **Soil** – It prefers slightly alkaline soil (pH 6.5).
- **Water** - It is partially resistant to dry periods with medium water demand (500-600 mm).
- **Temperature** – It needs a warm summer to set and ripen crop and is very sensitive to frost as it flowers in early Spring.
- **Light** – It needs full sunlight.

Hazelnut

- **Soil** – It prefers moderately fertile soil (pH 6-8). Very fertile soil produces sappy growth with less nuts.
- **Water** – It prefers free draining soil.

Chestnut

- **Soil** – It prefer light, acidic (pH 5.5-6.5), sandy soil in order to absorb potassium.
- **Water** - The water table should not be higher than 150 cm with high water demand (700 mm).
- **Temperature** – It is mainly grown as grafted trees in southern Europe and grown as coppiced, ungrafted trees in northern Europe.
- **Light** – It prefer a site which is sunny for most of the day and sheltered from the prevailing wind. It can be planted together in a grove, as in southern Europe.
- **Note** – It can be very long lived up to 500 years with a large crown so best to plant on the boundary of an orchard or in a separate grove or forest-orchard. Historically rind grafted chestnuts have been cultivated in domesticated forest-orchards – for example in the French Cevenne region.

Walnut

- **Soil** – It needs a deep (minimum of 60 cm), heavy loamy, slightly alkaline (pH 7.5 - 8) soil as they have a long tap root.
- **Water** – It needs a regular water supply especially in growing season but avoid poorly drained, waterlogged soil.
- **Temperature** – It needs shelter from spring frosts during the flowering period. Temperatures below -2oC will kill the majority of the female flowers. It needs an open site but protection from cold winds.
- **Note** - Most trees become very large. As they are out of scale with other fruit trees they should planted separately so they do not overshadow and stunt by competing for water. Prune minimally as they bleed sap. It does not transplant as easily as most fruit trees.

6 Planting

- **Design** - Mark out the planting pattern with canes as trees cannot be moved easily once they are planted.

- **Size of tree** - Ideally plant small one year old (maiden whip) or two year old (feathered maiden) trees.
- **The hole** - All 2-3 year old fruit trees (whips and feathered whips) need to be planted in a deep (>30 cm), square (>30 x 30 cm) hole. The turf around the hole should be removed creating a square (eg. 1 x 1 m) to avoid competition from grass and other plants. A small mound of soil could be created in the middle of the hole so the roots could be carefully spread out to the four corners of the hole. The roots will grow out and down into the soil if the original soil is returned. The graft union should always be well above the soil level otherwise unwanted shoots will develop from the rootstock.
- **Nutrients** - The roots will tend to stay in the hole area if any compost or fertiliser is added or if the roots are not splayed out. So organic matter and fertilisers should not be added as these can damage soil structure, create drainage sumps, discourage the roots from spreading and impede relationships with beneficial mycorrhizal fungi in the soil.
- **Mulch** – A mulch of wood chips, straw or rotting leaf litter can be added to the bare soil area to retain moisture and control the competitive growth of grass and other plants. An old carpet cut as a square with a diagonal slit can be used to suppress coarse grass in the first few years but ensuring that water can penetrate through the carpet and dyes or preservative chemicals are not leached into the soil.
- **Stakes** – Wooden stakes are only needed to hold tree guards. They are not needed to hold the tree upright as its own roots and stem will adapt their growth to the prevailing wind.
- **Tree guards** – These are needed to protect the succulent bark and leaves of the young fruit trees from grazing mammals such as voles, rabbits and deer. Wire netting of 12mm mesh and 60 cm tall) wrapped around the young tree will protect against voles and rabbits. Square fencing (1 x 1 m) with four stakes, a top rail and sheep netting may be needed if grazing livestock like sheep or cattle are included in the orchard plan.
- **Water** – Regardless of the weather each tree will need several buckets of water in the first few weeks. Watering may also be needed in the first summer if it is dry.
- **Records** – A label attached to the stake as well as a written record of the planting plan avoids losing the name of the fruit tree after a few years.
- **Aftercare** - Check the tree protection and post fastening, remove suckers, and remove all side shoots inside the tree guard. Renew any mulch and remove any weeds in the bare circle. Repeat this annually until leader growth is well above tube top when the ground can be allowed to grass over.

Successional planting – Fruit trees with standard rootstock can live a long time – apple and cherry – 100 years, pear and quince – 150 years, plum – 80 years. However it is worthwhile phasing some of the tree planting by leaving some open space in the orchard or replacing some poor growing trees. It also provides diversity of structure and space for wildlife.

7 Pruning

Pruning can control the growth of both vegetative leaves and sexual flowers by influencing some of the five plant hormones that regulate all fruit tree development and growth. Auxin promotes cell growth, elongation of the plant and root formation. Gibberellin regulates a wide range of processes involved in plant growth, organ development, and environmental responses, as well as transition to flowering, and the development of flowers, fruits, and seeds.

Traditional practice

Many guides imply that pruning was, and is, an essential part of fruit tree management. In fact, in many parts of Europe in the past little or no routine pruning was carried out, especially on plums and cherries, other than leader suppression, with just the occasional adjustment to reduce the risk of unbalance and wind-blow. Minimal pruning is both an acceptable policy, and a traditional and local practice.

Tips for pruning

- Hard pruning in winter encourages strong new shoots.
- Light pruning in summer encourages the formation of fruit buds for the following year.
- **Species** - Different species react to, and hence require, pruning in different ways. For example apples usually require more pruning than pears or quinces. Old cherries and plums often need no pruning.
- **Timing** - Pome or pip fruit, such as apples, pears and quince, need to be pruned in late winter as the trees are dormant. Then the sap is not fully flowing and new shoots with fruit buds have not developed. Stone fruit, like plums and cherries, need to be pruned in summer when the sap is rising and pruning cuts heal rapidly. At this time there will be less likelihood of the tree developing diseases such as bacterial canker and silver leaf curl.
- **Age of fruiting wood** – Apple, pear and sweet cherry fruit on two year old wood. Morello cherry, peach and nectarine fruit on new wood that is less than one year old. Plums, gages and damsons fruit on one and two year old wood.
- **Fruit and leaf buds** – On all fruit trees it is important to spot the difference between leaf buds and their position and the fatter fruit buds and their position on the branches. Some apple varieties bear fruit buds on the tip of a branch (eg. Bramley's seedling) - tip-bearing. Other apple varieties bear fruit buds on spurs or very short branches off a main branch (eg. Cox's orange pippin) making the flowers or fruit look more bunched – spur-bearing.
- **Leader Suppression** - Most fruit trees which are left unpruned produce a tall conical tree with a single dominant trunk from which the side branches arise and spread outwards. Leader suppression is a simple method of bud treatment that inhibits the natural tendency for the tree to have a single tall leader, and encourages wide branch angles and an open-centre. It works well on apples,

cherries and pears and unpredictably on some plums.

- Cut the leader back to two buds above the point where you want the top branch to form; this is the topping cut.
- Use a sharp blade to place a deep nick underneath the top bud. Remove the second bud completely.
- The following winter, remove the stunted central leader, cutting cleanly just above the top branch.

- **Pollarding** - Some very tall growing fruit trees have traditionally been maintained in parts of Europe (eg. east of England) as pollards. Pears on wild pear rootstocks can be up to 20 m high. Some pears were pollarded by cutting the trunk at about 2m on a 5-10 year cycle. It reduced windblow and the height for picking, and extended the tree's life but probably produced uneven crops.
- **Checking growth** – The excessive vegetative growth of pome and stone fruit trees (eg. with apple water shoots) can be checked by:
  - Summer pruning
  - Ring-barking
  - Root pruning – of stone fruit

Other fruit and nut trees

- **Peach, nectarine and apricot** – Standard trees should be pruned to a V with 3-5 main branches when growing or just before growth starts in early spring. If pruned in winter they are very susceptible to dieback and the risk of infection by silver leaf disease is greater.
- **Hazelnut** – Hazelnut trees can be pruned in the winter, spring, or summer. Winter pruning (when the catkins are releasing pollen) reduces congested growth and increases pollination. Spring or summer pruning produces much less return growth, and is useful in removing suckers and low-hanging limbs. In late summer (eg. August) the young growth of longer side shoots can be bent in half but not removed (brutted). This reduces vigour and lets in more light encouraging more female flowers.

Formative pruning

Formative pruning just means pruning the tree into the preferred final balanced shape – conical, round or open-centred. This is the most important period of pruning during the tree's life. If carried out incorrectly the tree will require lots of corrective work in later years. After a few more years you will need to start maintenance pruning which is done annually.

Objective

- Develop a strong balanced branch system with an open habit. This will allow light into the centre and air to circulate.

Developing the shape

The ideal is to have 4-8 evenly spaced main branches radiating from the trunk like the spokes on a wheel if viewed from above, but not all from a single whorl of branches around the trunk. These will form the framework from which the fruit-producing side branches and spurs will develop. These branches should be at a safe distance above the ground level to bear and ripen the fruit. For standard trees the main stem should be

pruned to create a 2 m trunk.

The height of the central leader (trunk) does not increase from the base as the tree grows - only the girth increases. Therefore the height at which each branch forms remains the same throughout the tree's life. This means the only way to raise the height of the laterals is by removing them in favour of higher growth. As doing this may compromise the shape and balance of the tree it is important to begin forming the branches so that they attain the right height while the tree is still young.

- **Open centred tree** – Prune to make an open-centred tree in the third or fourth growing year. This will allow air and light into the middle of the tree, avoiding fungal diseases and producing bigger fruit.
- **Conical tree** - Prune by leaving the central vertical leading branch. This is best for trees on standard rootstock which can grow up to 5 m with a trunk up to 2 m.

Basic equipment includes secateurs and loppers.

Maintenance pruning

Objectives

- Remove dead and diseased wood.
- Open up the tree to allow light in and good air flow through the tree.
- Remove any touching or rubbing branches.
- Remove or reduce the number of branches growing at acute angles from the trunk.
- Reduce the risk of wind damage in exposed locations.
- Make it easier and safer to pick fruit and mow under the tree.

For apple trees only remove up to 25% each year. This is easy to spot if the prunings are left under the tree until the pruning is completed.

Guide 2 (Managing with nature) explains some of the pros and cons of maintenance pruning. It suggests that deadwood provides a habitat and food for beneficial wildlife and the removal of branches and leaves can disturb the natural balance of vegetative and fruit bud growth.

Restorative pruning

Objectives

- Conserve local heritage varieties and their long-term biodiversity value by conserving the old trees.
- Restore the shape and structure of old, neglected trees.
- Prune large branches that create an imbalanced tree and may fall.
- Thin dense growth and open a crowded crown to promote a fruit crop.

Many traditional orchards have suffered from extensive neglect so the tree health, shape and structure needs to be restored. Old fruit trees of up to 100 years old can still be found in traditional orchards. They may not have been pruned and managed for several years. The first step should be pruning for restoration and a stable structure. However large orchards take a long time to prune and once regular pruning becomes a routine it must be continued. A restoration project may take at least three years.

Safety - It should also be recognised that unpruned old trees on standard rootstocks will be high and wide. They will need ladders to both pick the fruit and prune the large branches. This may have health and safety implications.

Tools - Basic equipment includes an extendable pruning saw, ladder, gloves, goggles, hard hat and another person for safety.

Case studies

- The Kosztela Project (PL)

Downloadable pdf files

- Planning and planting new orchards – Suffolk Traditional Orchard Group
- Site and tree selection of traditional orchards – Natural England
- Planning and establishing fruit trees in a traditional orchard – Natural England
- Restoring fruit trees – Ancient Tree Forum

Videos

- Planning and planting your own orchard – Three Counties Orchard Project
- Management of veteran fruit trees – VETree Project
- Maintaining fruit trees in orchards – Gloucestershire Orchard Trust
- Kosztela Project – traditional orchards in Poland – PUR Project

Part 4 - Identifying and growing fruit and nut trees

Aim

To learn about the identification of different species and varieties of fruit and nut trees, and their propagation.

Objectives

The learner should be able to know about, understand, describe and demonstrate (in the context of their local area and country):

- The range of fruit and nut tree species and varieties suitable for the local conditions.
- The value of fruit tree diversity and local heritage varieties.
- How to identify fruit and nut tree varieties - using local experts, regional/ national collections, books, identification keys, websites and DNA fingerprinting.
- How fruit trees are pollinated and the need for compatible varieties for cross-pollination.
- The importance of pollinators and types of pollination.
- The impacts of climate change on fruit trees and orchards.
- How to propagate fruit trees and their rootstocks by seed, cuttings, stooling and different grafts.
- The value and techniques of grafting fruit trees for size, productivity, and plant health.

Optional teaching approaches

Plan a visit to a traditional orchard at flowering and/or early fruiting time to describe, demonstrate, discuss and practice:

- Identifying and comparing the characteristics of different fruit and nut tree species and varieties.
- Identifying using a range of fruit and leaves from a few common varieties and a custom-made identification key of a few diagnostic characteristics.
- Observing flower parts, types of pollination and pollinators.
- Observing graft unions in different sized trees.
- Identifying potential scionwood and graft marks.
- Rind or bark grafting onto 15 cm cut branches.
- Producing rootstocks from stools.

Arrange a room with tables, tools, rootstocks and a range of scion wood to describe, demonstrate, discuss and practice:

- Making the simple whip-and-tongue graft of rootstock and scion.

- Cutting and inserting a bud for bud grafting - in mid/late-summer.
- Observing a small range of alternative grafts - with video and diagrams.
- Planting stratified seed of fruit and nut trees.
- Purchasing and caring for grafting tools and equipment and their safe handling.
- Arrange a tasting of local heritage varieties in comparison with modern varieties bought from a supermarket. Try blind tasting and memory.
- Exchanging experiences amongst participants.

1 Diversity of fruit and nut trees

Across Europe there is a huge diversity of fruit and nut trees. As the climate changes and food tastes change, many new fruit and nut trees are likely to be introduced to orchards. Traditionally managed orchards of the future may well have many recently introduced trees. The main fruit trees in Europe are mostly members of the Rose family but many different genera and species are represented.

- **The stone fruit trees** (6 species) – Plum (including damson, bullace, gage and mirabelle), cherry or myrobalan plum, sweet cherry, sour or morello cherry, apricot, peach (including nectarine).
- **The pome fruit trees** (4 species) – Apple, pear, quince, medlar.
- **Other fruit trees** (2 species) – Mulberry, elderberry.
- **The nut trees** (4 species) – Sweet chestnut, walnut, hazelnut (including filbert), almond.

There are many recently imported and popularised fruit and nut trees in Europe – eg. Persimmon, juneberry, pecan and hickory. Also there are many fruit tree species such as fig or olive which are grown in single species groves rather than traditional orchards, or species like cornelian cherry, rowan or stone pine which are recognised as wild species.

Ref - Spreadsheet of European fruit and nut tree species – CORE Website

Terms

Species - A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding. But in life there are exceptions.

Cultivar - A type of plant that people have bred for desired traits, which are reproduced in each new generation by a method such as grafting. The word cultivar was coined as a term which means cultivated variety. The International Union for the Protection of New Varieties of Plants (UPOV) offers legal protection of plant cultivars to persons or organisations that introduce new cultivars to commerce. UPOV requires that a cultivar be distinct, uniform, and stable. Formally species and cultivars are written like this - *Malus domestica* 'Blenheim Orange'. Confusingly the term variety is widely used instead of cultivar by both the public and orchardists, and so will be used by this project.

Variety – In strict horticultural terms a variety is a cultivar that comes true from seed, retaining its distinguishing characteristics when grown from seed. However the term for a variety means a cultivar which may or may not come true from seed. So it's all very confusing!

Clone - Cultivars that are produced asexually are genetically identical and known as clones. This includes fruit propagated by dividing, layering, cuttings, grafting and budding.

Phenotype - An organism's observable traits, such as fruit size, patterning and colour.

Genotype - The genetic contribution to the phenotype. Some traits are largely determined by the genotype, while other traits are largely determined by environmental factors.

National collections of fruit and nut trees

The recording and conservation of fruit trees is based on regional and national collections. Many European countries have regional or national collections of fruit trees. These are sometimes called mother collections. A registered National Plant Collection of fruit trees is a documented collection that is usually available for people to view. For example in the National Fruit Collection at Brogdale is one of the largest fruit collections in the world and includes over 3,500 named apple, pear, plum, cherry, bush fruit, vine and cobnut cultivars.

2 Valuing heritage varieties

Old, heritage varieties of fruit and nut trees have been cultivated for a long time, sometimes for centuries. They have retained their wide range of unique flavours, fragrances, colours and other qualities and have a wider range of uses that have been forgotten in the modern household.

Heritage varieties – Heritage or heirloom varieties have been passed down from generation to generation. These originated from seedlings which were selected for their taste, cooking and keeping qualities as well as suitability for the local climate and soil. They were then propagated by grafting or budding and distributed more widely. Also pilgrimages and crusades brought an expansion of varieties through new plants and scions from other countries. Some heritage varieties will have been bred by crossing two parent varieties.

Peak century - The climax of diversity in fruit varieties across Europe has been in the century between 1850 and 1950 when research institutions, wealthy and aristocratic landowners, their gardeners or nurseries would have made the selection and named, exhibited and distributed the newly selected variety. At that time specific breeding was hugely expanded on large estates and in research and plant breeding institutes. For example in Germany systematic breeding and research was founded with the Kaiser Wilhelm Institute in 1929.

Local distinctiveness - Local varieties often thrive best in the area where they were bred, and are therefore powerful symbols of local distinctiveness. Old and regional local varieties are especially suitable for the cultivation of traditional orchards but are not so widely available to purchase.

Year round supply - In the past traditional orchards had to satisfy the needs of the rural population for a supply of preserved fruit and nuts throughout the year. There had to be fruit tree species and varieties suitable for different purposes: cooking, baking, drying, preserving, for the farmers and for feeding the cattle. The range of fruit had to last at best from autumn to spring and even up to the following harvest.

Future for heritage varieties

Genetic diversity - Traditional orchards are important for the preservation of the genetic diversity in fruit varieties. Conserving this agrobiodiversity is vital for breeding new crop varieties, for adapting to climate change and for developing resistance against diseases and pests.

Disease resistance - Heritage varieties are often better equipped to survive the local climate and soil where they were developed. However they may be susceptible to certain diseases such as canker and scab. Modern varieties may have some disease resistance. The original plant material must have good physical growth and has to be free of disease or infestation.

Health benefits - Polyphenols are aromatic compounds that mostly occur in or directly under the apple peel. Research is being carried out by the Bund Group in Lemgo (DE) in collaboration with the Charité Berlin Allergy Centre on the polyphenol content in old apple varieties. The studies showed that apple allergy sufferers had less problems with hay fever if they regularly consume the older varieties with higher polyphenol levels.

Loss of diversity

There has been a huge loss of fruit tree diversity across Europe. A few modern fruit tree varieties have been bred to suit popular sweet tastes and give an unblemished, standardised appearance. In commercial fruit production there are only about 25 varieties of apple from more than 8,000 known varieties all over Europe. So most consumers may know and be happy with only a few standardised modern apples varieties which will be the same in all European supermarkets.

Modern varieties

Modern fruit tree varieties are bred so they:

- are a standard shape, size and taste.
- are resistant to plant diseases.
- need regular use of pesticides to produce good looking fruit.
- can be easily stored and transported.
- contain a high percentage of sugar to suit popular tastes. Often these varieties have a limited and increasingly sweet variety of flavours.

3 Identifying varieties

Each species and variety has different characteristics and hence requirements for management. So their identification is important for the management of any traditional orchard.

Fruit trees can be identified from their phenotype (physical characteristics) but more accurately from their genotype (genetic characteristics).

The species (eg. pear or apple) are fairly easy to identify by their phenotype – their growth habit, root structure, bark, leaves, flower as well as fruit.

Ref - Fruit tree identification – Peoples Trust for Endangered Species

Visual identification of varieties

Identification by physical characteristics, or phenotype, depends primarily upon a number of botanical features of the fruit.

To identify a variety as reliably as possible three or more mature fruits are needed preferably from the sunny outer and upper side of the tree. The fruit should be without deformation, pests or disease, but with the stalk and perhaps some leaves.

Identifiers - Reference books, identification keys, websites, apps, old botanical illustrations or paintings as well as experts can be used to determine the diagnostic characteristics of the variety.

Ref - Example of an identification service – Marcher Apple Network

Experts - If help is needed to determine or confirm the variety the best way is to visit a local identification course, where pomologists or the local orchard group can give advice. Other possibilities are to send the fruits to a pomology association or community orchard group. Sometimes older people may recognise some local old varieties.

Apple and other pome fruit

The most reliable characteristics of the fruit include:

- Skin (colour, bloom, lenticels, hairline and russeting)
- Size of fruit (small to large)
- Shape of fruit (side view and cross-section)
- Shape of eye and basin (closed to open eye, narrow to broad, shallow to deep basin, russeted, ribbed)
- Shape of cavity (narrow to broad, shallow to deep, russeted)
- Length and size of stalk (short to long, thick to thin)
- Colour, texture and flavour of flesh

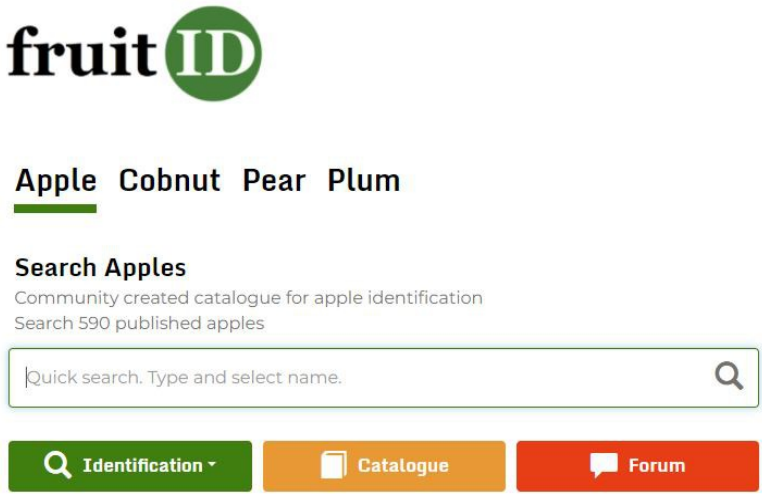
In addition there are other characteristics for identification:

- Flowers – colour, size and flowering time
- Buds – spur-bearing or tip-bearing
- Cropping – heavy cropping (eg. Golden Delicious), hardiness (eg. Antonovka), ripening time for picking and consumption
- Leaf – shape, size and edge with sharp or blunt margins

All these diagnostic characteristics can vary enormously. They can be strongly influenced by the weather, pests and diseases, the age of the tree etc. Fruits also often differ on the sunny and shady sides of the tree.

- Frost damage can give russeting.
- Cold springs and a heavy crop will produce small fruit.
- The king fruit (apple at centre of a flower cluster) will usually be bigger, with a bulbous stalk and atypically shaped.
- Old trees in grass (hence with less nitrogen) produce more highly coloured fruit.

So the same variety grown in different European countries can vary considerably.



FruitID uses a wide range of diagnostic characteristics to identify fruit trees by sight, touch and taste.

Ref - FruitID.com – Fruit ID

Apple Name (US) uses the following characteristics - Skin, Stem/Cavity, Shape/Size, Basin, Core/Seeds, Flesh/Flavour, Cultural/Uses.

Ref - Apple Name – Apple Name, US

Plum and stone fruit

The most reliable characteristics of the fruit include:

- Stone – adhering to flesh, shape, size
- Shape – round, conical, oblong, grooved
- Size – small to large
- Skin colour – yellow to black, markings
- Flesh – pale yellow to orange
- Season – early to late

Ref - Worcestershire Plums – Worcestershire Orchards

Identification of fruit species and cultivars

- **Let your participants play a memory game with a fruit species. Try to find two of the same variety out of a bucket full of fruit such as apples. This trains accurate observation.**
- **Take detailed photos of bark, branches, fruit etc. and let participants find the real objects in the orchard by comparison.**
- **Spread fruit, leaves, bark, buds etc. (real or photos) of fruit tree species on a table and let the participants group them together with the same species.**
- **Each participant describes a fruit or tree in as much detail as possible.**
- **Participants practice identifying by using a range of fruit and leaves from a few common varieties and a custom-made identification key of a few diagnostic characteristics.**

DNA identification of varieties

Varieties (eg. of apple) are often difficult to identify by their phenotype but can be identified more accurately by DNA analysis. If the visual identification is not easy DNA identification may be possible, but only if the DNA for the variety has been sequenced and recorded for matching.

The complete genome of the apple was sequenced by an Italian-led consortium in 2010. The method of analysis includes a polymerase chain reaction (PCR) – as used with Covid PCR tests. The apple genome has approximately 57,000 genes, which was the highest number of any plant genome studied at the time, and more genes than the human genome which has about 25,000 genes.

Ref - DNA fingerprinting analysis – Marcher Apple Network

4 Conserving local and heritage varieties

Local surveys

Sometimes it is a challenge to find out the owners of a traditional orchard or old tree and get permission for access or to provide support. Those who planted the trees are probably old or may have already died. But it is always worth asking to get more information about the orchard or heritage variety.

Ref - Example of a local orchard survey – East of England Apples and Orchards Project

Learning from previous growers

- Map the orchards and fruit trees of a village or region.
- Study the historic literature about regional and local pomology.
- Find and interview the orchard owner about the species and varieties and about the traditional use of the harvest.
- Get scions from old trees of local heritage varieties in winter and graft them in the spring to produce new trees of those varieties.
- Plant new trees by grafting and budding local heritage varieties.
- Try to determinate interesting unknown varieties.
- Exchange plant material and experiences with other local projects that are interested in local heritage varieties.

Varieties

In a normal non-commercial orchard, planting local and heritage varieties is always advisable. This helps conserve the genetic diversity of old heritage varieties and adds to the local distinctiveness of an area. This agrobiodiversity is increasing needed for the rarer genes of heritage varieties in order to adapt to climate change, and for future plant breeding programmes.

Apples

Apples have the highest genetic diversity of all temperate fruit trees. For each gene (eg. to determine fruit texture) there are a variety of alleles with many possibilities of different combinations at fertilisation. So they are highly heterozygous.

The varieties differ in many morphological characteristics including:

- the strength of tree growth
- the structure of the roots and crown
- resistance to frost
- susceptibility to disease
- the size, colour, shape and taste of the fruit
- the time of fruit ripening, storage period and range of uses

Pears

As in the case of apple trees, pears are characterized by a high variability of many characteristics. The old pear varieties include small (about 50 g) and very large (about 350 g), summer, autumn and winter varieties.

Plums

There are several groups of plums with different ripening times, taste and size. There is some dispute about whether they are all the same species – Prunus domestica. Some pomologists consider damson and bullace to be Prunus insititia.

- Mirabelle plum
- Damson
- Bullace

- Plum
- Gage or greengage
- Prune

Cherries

Sour cherries grown from suckers usually produce small, dark fruits, with a strong, sharp taste, often used to produce alcohol.

5 Managing in a changing climate

The impacts of climate change will vary considerably in different parts of Europe. The south will be harder hit than the north. The south will be more affected by drought, urban heat and agricultural decline, while the north will be affected by flood and wildfire. Basically weather will be unpredictable but the climate (weather over a 30 year period) will get warmer – possibly progressively. So generally there will be warm, wet winters and hot, dry summers over much of Europe.

Orchards are very susceptible to the impacts of climate change, but early planning can help growers to adapt to these risks, as well as be aware of the opportunities for the future development of traditional orchards and heritage varieties.

Orchards can also help to mitigate climate change by absorbing and storing carbon in their wood and underlying soil, and protecting the landscape by reducing soil erosion and alleviating flood risk.

Key concerns

Already many fruit trees are flowering at least one week earlier than 50 years ago and new pests and diseases are moving northward. Climate change already impacts fruit trees in several ways:

- Inadequate winter chill for dormancy and vernalization (induction of flowering by prolonged cold).
- Stop-start springs leading to weak blossom and poor fruit set.
- New and increased pest and disease pressures eg. scab, mildew, fireblight, mistletoe.
- Heat and drought stress reducing yield and fruit/juice quality.
- Root death from winter water-logging.
- Unpredictable summer weather (often hot and dry) affecting cropping patterns.
- Earlier blossom and danger of damage by increasing occurrence of late frosts.

Adaptation

However there are several ways of adapting to climate change that can minimise these impacts on orchards and fruit trees:

- Choose standard trees on seedling and standard rootstocks (eg. M25, Bittenfelder, Antonovka) because they have deep and sturdy root structures.
- Observe the growth of different varieties in extreme climate conditions.
- Choose drought resistant species and cultivars eg. more pears, cherries, walnuts.

- Plant trees in soils and sites with higher humidity and more shade.
- Irrigate young trees for the first 5 years eg. water bags, irrigation systems.

Ref - Climate change series - Focus on apple and pear orchards - Farming Futures

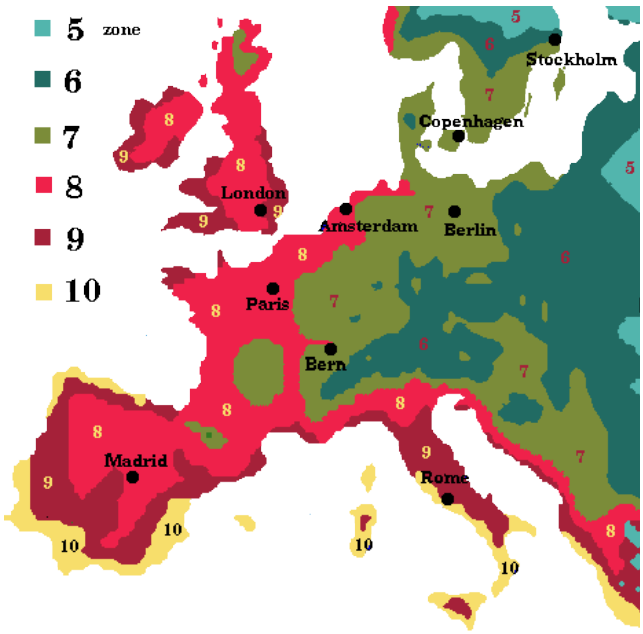
Checking the climate in Europe

The following links from PlantMaps provide interactive plant hardiness zone maps for Europe based on a USDA system. Also provided are maps indicating records of high/low temperatures and dates of first and last frosts.

Ref - Plant Maps - European Hardiness Zone Maps

For a specific European country check:

- First and last frost date map.
- Record high and low temperatures.
- Hardiness Zones - based on the US Dept of Agriculture Hardiness Zones for growing plants. There are 13 zones defined by annual extreme minimum temperature. In the US zones are moving north about 2 km/yr. So zones are half a zone warmer since 1990.



6 Supporting pollinators

The right weather at blossom time is vital for fruit trees to set fruit. Insect pollinators need warm, calm and dry weather to fly. They can be encouraged and supported in several ways:

- Companion planting in the orchard, as described in Guide 2 (Managing with nature).
- Encouraging a beekeeper to place hives in the orchard between March and May.
- Building bee homes in the orchard to attract solitary bees, which are more effective pollinators than honey bees.

Pollinators

Pollination by wind - Wind pollination requires a large amount of very light pollen that can easily reach the stigma. In fruit growing, this applies to walnuts, hazelnuts and chestnuts.

Pollination by insects - The fruit tree blossoms must be attractive to the pollinator. This is achieved through optical or chemical stimuli such as fragrance and colour. The pollinator must be able to pick up the pollen easily and to release it to the stigma just as easily. It does this job reliably with a reward in the form of pollen or nectar.

- Bees will only cross-pollinate apples, pears and sweet cherries when there is no

rain, wind or smoke and the temperature is over 12 deg C (or 8 deg C for wild bees).

- Honey bees are the commonest pollinators of fruit trees. Other pollinators include bumblebees, solitary bees (mining and mason bees), flies and moths. However bumblebees and solitary bees are more effective pollinators than honey bees.
- The balance between wild bees and honey bees as pollinators is important for the natural balance.
- Wild bees fly at lower temperatures and not as far from the nest as honey bees. Some wild bee species may pollinate up to 5,000 flowers per day.
- Depending on the distance, a honey bee flies up to 30 times per day pollinating up to 250 flowers per day.
- Good, complete pollination significantly increases the quality and yield of fruit e.g. weight, shape, content, storability.

Cross-pollination

Normally in fruit trees, as well as all flowering plants, the pollen comes from a different flower (cross-pollinated) and not from the same flower (self-pollinated). The pollen often comes from a nearby flower of the same tree. This is called neighbour pollination. So the design of an orchard needs to consider cross-pollination by varieties that flower at the same time.

All the non self-fertile fruit trees (apples, pears, sweet cherries and nut trees) need cross-pollination from a compatible polliniser (another tree of the same or closely related species that flowers at the same time but not necessarily the same variety). So they are planted in groups. Compatible apple and pear varieties are selected on the basis of common or overlapping bloom times and flowering groups (1-6 or A-H).

- Varieties which are known to produce low quantities of pollen or poor quality pollen are excluded.
- Varieties which are closely-related (for example share a common parent) are excluded from the selection because cross-pollination is less effective between close relatives.
- Varieties which belong to the same genetic incompatibility group are excluded (even though they may not be closely related to the host variety) because cross-pollination will be less successful or may not be possible at all.
- Crab or wild apples (Malus sylvestris) with their long flowering season are good apple tree pollinisers for many apple varieties.

All the plum species and varieties are very closely related and are generally compatible, so if they are in flower at the same time they should cross-pollinate. The same range of pollination groups are used for pears, plums and cherries. Sweet cherries exhibit considerable incompatibility between varieties. However sour cherries will pollinate sweet cherries that are in bloom at the same time.

Walnut, hazelnut and sweet chestnut trees are not self-fertile and so need to be planted in groups.

Ref - Online Pollination Checker - Ashridge Nurseries

Self-pollination

Self-pollination (also called direct pollination) means that the male stamens of a

hermaphrodite flower ripen at the same time as the female stigma. This offers the possibility that a plant can still get a lot of fruit on its own and build up a large population. Self-pollination reduces the genetic diversity and thus also the changeability of a species. With hermaphrodite flowers (stamens and stigmas are in the same flower), there are different ways for the tree to prevent self-pollination:

- The stamens ripen before the stigma (Proterandry)
- The stigmas ripen before the stamens (Proterogynia)
- Infertility with own pollen

Self-fertile trees

Apricots, peaches, nectarines, almonds, medlars, quinces and mulberries are all reliably self-fertile. Self-fertile and partially self-fertile varieties do not require cross pollination from another variety to fertilise their flowers and produce fruit. Self-fertile fruit trees do not require any pollinating partners and so fruit is almost guaranteed on a healthy tree. They can be grown on their own. However they may benefit from some cross pollination.

Value of self-fertile trees - Inadequate pollination is often the reason why seemingly healthy fruit trees do not produce fruit. In an area with lots of apple trees and orchards there will usually be sufficient pollinators. However, to avoid the risk completely, choose a self-fertile variety.

- Apple – There are only a few self-fertile or partially self-fertile varieties eg. Gala and Cox's Orange Pippin. Most are modern varieties.
- Pear – There are a few self-fertile or partially self-fertile varieties eg. Conference and Williams Bon Chrétien.
- Sweet cherry – Stella is self-fertile. Most varieties are not self-fertile.
- Sour cherry – All are self-fertile. It can fertilise sweet cherry.
- Plum, including damson and gage – Most are self-fertile.
- Peach – Most are self-fertile, except Hale offspring.
- Nectarine – All are self-fertile.
- Apricot – Many are self-fertile.
- Quince – All are self-fertile.

Ploidy

Diploidy – Most apple and pear trees are diploid with just two sets of chromosomes.

Triploidy – Triploid trees have three complete haploid sets of chromosomes. This means that triploid cultivars are usually large, vigorous trees with large fruit and heavy crops. However they produce very little viable pollen and so are very poor pollinators with hardly any or no seeds. These include, for example, Alexander Lucas pear, Boskoop, Bramley and Blenheim Orange apple varieties.

Hexaploidy - Most plums, damsons and bullaces are hexaploid with six sets of chromosomes and may be self-compatible or self-incompatible.

7 Propagating fruit and nut trees

There are various options for propagating fruit and nut trees. Natural methods of propagation are described in Guide 2, section 9.

Generative propagation from seed

Most species of fruit trees cannot be propagated by seed true to the variety of the parent tree. This is because a number of other trees will be involved in the pollination. A second suitable variety is needed for fertilisation. After pollination by wind or insects the seed contains the genetic trait of both parent trees. Seedlings grown from this seed are therefore not uniform or true to the parent variety. These are often used as the rootstock for many grafts. However some varieties (eg. Antonovka and Borowinka) which are used as rootstock come true from seedlings. Wildings are seedlings grown in the wild from discarded fruit. They can often be spotted at blossom and fruiting time on roadsides or in hedgerows. Several wildings have been named and cultivated as new varieties.

Growing seedlings

- **Clean seed** - Separate the seeds from the pulp of the fruit by mashing, washing and sieving. Do not let the seed dry.
- **Stratify seed** - Either sow the seeds in a plant pot with 50-50 potting compost and sharp sand buried to about 1 cm. Then leave the pot outside over winter with a fine net covering to protect from mice and check for moulds.
- Or stratify the seeds in a sealed pot or plastic bag in the fridge mixed with 50-50 potting compost and sharp sand. For stone fruit the shell will need to be slightly cracked or abraded.
- Label with full details and date and check for germination in the spring. Then carefully pot on the small seedlings into a larger pot.
- Pome fruit, like apple, pear and quince, are easier to germinate than stone fruit like plum, peach or cherry.

Stratification

Cold stratification breaks seed dormancy to start germination by exposure to cold (near freezing) conditions. All fruit tree seed needs some stratification. Naturally this would happen during a cold winter or when the seed coat or shell starts to crack or be abraded, as in the digestive system of a bird or mammal as part of seed dispersal. Many fruit and nut tree species originated on mountains in central Asia or the eastern Mediterranean with cold winters and with bears, birds or livestock to abrade the seed and disperse the fruit.

Vegetative propagation from cuttings, layering or stools

Asexual reproduction of parts of the mother tree can produce genetically identical offspring (or clones). In this way all characteristics of the tree are preserved, such as growth form, vigour, foliage, fruit colour, taste and pest and disease resistance. Vegetative propagation can be done in several ways:

- Hardwood cuttings - These can be done in winter, for example with mulberry, quince and elderberry.
- Suckering - The plum family, quince and sour cherry naturally produce suckers which can easily be cut and grown separately.
- Stooling - This involves progressively earthing up rootstock (such as MM106, quince), often with woodchips so that it tillers to produce several shoots which are cut and then grown on separately.
- Layering - A living young shoot or branch is bent or pegged down to cover with

soil, for example with quince or hazel cobnut. Air layering involves cutting away the bark of a small branch, adding hormone rooting powder and covering the exposed surface with damp moss or similar and a plastic film.

8 Grafting

All fruit trees of a known variety can only be reproduced identically from one of these methods or a graft but not from a seed. A fruit tree, such as apple, pear, quince, medlar or sour cherry or a nut tree of known variety is commonly grafted to produce a tree of that variety.

Scion wood (straight one year old twigs, cut in February/ March) or bud wood (young leaf bud cut in June/ July) is grafted onto a new rootstock or tree. There must be contact between the two cambium layers. This is a 0.01-0.2 mm thin green layer just below the bark where the core of its living activity occurs, including the flow of sap. The vascular tissue of the scion or bud must be in direct contact with the vascular tissue of the rootstock. This ensures that the wound response cells touch, allowing the tree to heal and form a bond.

- The scion wood or bud wood from a tree of known variety will bear the fruit of that variety.
- The rootstock with its root and short stem mainly influences the growth, strength and shape of the tree.

Grafting courses or workshops are very popular. Participants can finish the course with one or more grafted fruit trees and a traditional skill for life.

Why graft?

- It is a cheap and quick way of reproducing the same variety. A small amount of scion wood from one fruit tree can produce hundreds of trees.
- It controls the tree's size, shape, disease resistance and adaptability to the climate and soil etc.
- It speeds up breeding new varieties because the fruit may be produced after about 3 years on dwarfing rootstock whereas it may take 10 years on trees grown from seedlings.
- It is possible to change the variety of an older tree by top grafting.
- It is possible to grow more than one variety on the same tree, called a family tree.
- It is a miraculous and intimate process but few people have the skills.

Rootstocks

Rootstocks are a root system of known vigour, i.e. it is predictable how quickly the tree will grow and to what size. Rootstocks can be grown from seeds, cuttings and stool beds. A wide range of standard rootstocks are used throughout Europe. Scion wood of a specific variety is grafted onto a rootstock and grown into fruit trees.

Standard rootstocks

Old traditional orchards will usually have fruit trees with standard rootstocks. These will grow vigorously, become tall trees and have tall trunks (about 2 m as protection from grazing animals). They also have deep roots so they will bear fruit even in relatively

poor soil. Standard apple trees may live to over 100 years, and pears even longer. However they will only fruit after 5-10 years. More modern fruit trees are now grown on dwarf or semi-standard rootstock so they have fruit that can be picked from the ground and after 3 or so years.

Old rootstocks

In the past orchard growers produced their own rootstocks from seedlings or possibly cuttings. This was before the selective breeding of rootstock to control disease, growth and productivity. For example the M25 rootstock was selectively bred by the East Malling Research Station in the UK to produce the M series of rootstocks eg, the dwarf M9, the standard M25.

There are a variety of traditional standard rootstocks:

- Apples – Crab or wild apple or hawthorn rootstocks. Paradise stocks were the basis for the Malling series. In the UK Free stocks were produced from cider pomace pips and Crab stocks from the wild species (Malus sylvestris).
- Pear – Pear species (eg. Caucasian pear (Pyrus caucasica) in Poland), quince or hawthorn rootstocks. Free stocks were produced from perry pomace pips.
- Quince and medlar - Quince or hawthorn rootstocks.
- Plums – Myrobalan plum rootstocks for a 5 m. plum tree with >1 m. trunk.
- Sweet cherry - In former times, cherries were propagated in a specific way by planting seedlings of wild cherries (Prunus avium). These were grafted after 3-4 years at a height of about 2.5 m. This method of reproduction limited frost damage as wild cherry seedlings are more resistant to frost than fruit varieties.

Nowadays there are many new rootstocks that have been bred by research institutions.

Ref - Spreadsheet of common standard rootstocks – CORE Website

Grafting techniques

There are many different grafting techniques. The practice of grafting is best demonstrated by an experienced practitioner. There are also helpful videos on the internet.

Cleanliness - With all types of grafting cleanliness is very important. The cut surfaces must neither be touched or dry out. Both the scion and rootstock should be virus free if possible.

Equipment

- **Rootstocks** - are selected and ordered from a nursery in the winter or cut from a stool bed. Seedling trees from one's own production can be used as rootstocks but with unreliable results.
- **Secateurs and pole saw** - are used to collect the scion wood.
- **Scion wood** - of a known tree variety are collected in midwinter as a strong, straight shoot about 30 cm long – tied together, labelled and heeled in the ground in a shady place or stored in a fridge wrapped in damp paper in a plastic bag.
- **Grafting knife** - with just one bevelled edge can be sharpened with a stone to make a very sharp blade. Most knives have two bevelled edges and so are not as sharp. Budding knives have an extra section for budding.
- **Grafting tape** - can be thin parafilm or 2 cm strips of very thin plastic bags (eg.

supermarket fruit bags).

- **Grafting sealant or wax** - can be used to seal the top of the scion wood and over the grafting tape.
- **Plant labels** - with metal ties marked with soft pencil or permanent marker.
- **First aid kit** - as there is some risk involved with a sharp knife.
- **Plastic bags/buckets** - for keeping scion wood and rootstocks fresh before and after grafting.

Bud grafting in summer

A small bud is cut from a twig and slotted into a cut pocket in a rootstock or tree branch. Bud grafting (or chip budding) does not include woody tissue. Only the bud and some epidermal tissue is attached to a new rootstock. The optimal thickness of rootstock to be budded is finger size. Bigger than that, and it will need to be grafted. The roots of the rootstock should be slightly trimmed to stimulate the grafted bud to sprout. Trees are budded in the late summer while the tree is still running sap.

T-budding (or shield budding) is done in early summer, June and July, when the sap is rising at its strongest. Chip budding is done later in the year, September, when things are calming down. As with all grafting to propagate fruit trees, the basic aim is to fuse the rootstock to the scion wood.

T-budding is a more traditional method of propagation.

- Make a deep horizontal cut on the rootstock and then a vertical cut downwards.
- Peel back the bark to reveal the cambium, and slip the bud inside.

Chip budding is commonly practiced commercially, especially in the UK, as it produces a straighter trunk on the resulting tree.

- Make a cut downwards on the rootstock at 30 degrees and then 2 cm above make another cut downwards at 30 degrees to meet the original cut.
- Make similar sized and shaped cuts on a bud of the scion to insert into the rootstock cut and bind with tape.

Ref - Chip budding – Peoples Trust for Endangered Species

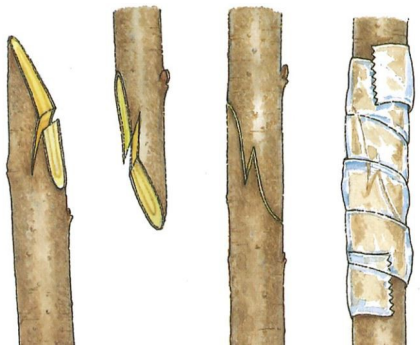
Bench grafting in winter

Strong, straight annual shoots are cut as scion and treated like cuttings until they are

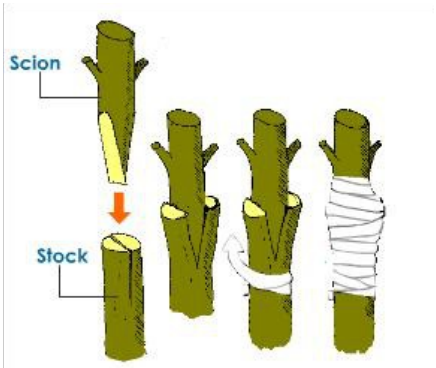
used. Bench grafting can be done in late winter – a month or so before bud break. In bench grafting dormant wood is grafted onto a dormant rootstock.

Whip and tongue grafting of apple is the simplest and commonest grafting to introduce to beginners. The scion and rootstock should be of equal thickness, up to 1 cm.

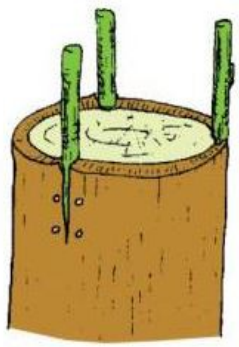
- Collect scion wood in midwinter (January to early March) by cutting strong, straight shoots about 30 cm long. In early spring cut a straight 3 cm sliver of wood on the opposite side to a healthy bud. Then cut a 1 cm tongue one third of the way down the sliver, by rocking the knife to and fro. It may help to practice with an apple shoot.
- Cut the rootstock down to 20 cm with a gentle sloping cut with secateurs. On the high side of the sloping cut, cut a sliver of wood to match the scion wood sliver with a single straight push of the knife. Cut a 1 cm tongue to match that in the scion wood by gently rocking the grafting knife up and down.
- Gently fit the tongue of the scion into that of the rootstock. The light green outer cambium layers should fit snugly together so they can grow into a cambial bridge.
- Wrap grafting tape several times around the wider area of the scion and rootstock joint to bind them together.
- Plant the rootstock in a pot with soil and keep in a greenhouse or area protected from the wind and direct sunlight. The new tree should be labelled and any lower leaf or shoot buds removed leaving the top one or two shoot buds to grow. The grafting tape can be removed after about 3 months.



Whip and Tongue graft



Cleft graft



Bark graft

Other types of bench graft

Cleft grafting is a method for top working fruit trees (apples, cherries, pears, and peaches) in order to change varieties. The rootstock should be 2-10 cm diameter. A cleft or split is made 5 cm through the middle of the rootstock.

Bark grafting is used primarily to top work trees. In contrast to cleft grafting, this technique can be applied to rootstock of larger diameter (10-30 cm) and is done during early spring (April or May) when the bark slips easily from the wood but before major sap flow. The rootstock is severed with a sharp saw, leaving a clean cut as with cleft grafting.

Intergrafting involves an interstock which is grafted between the rootstock and the scion. It can be particularly valuable when the scion and rootstock are incompatible and does not form a straight stable stem. In such cases, an interstock that is compatible with both rootstock and scion is used. An interstock could increase the disease resistance or cold hardiness of the scion. Plants also may be double grafted with an interstock to impart dwarfness or influence flowering and fruiting of a scion.

There are many other methods of grafting for different sized rootstocks, branches or scion wood, as well as different times of year.

Teaching tips

- **In a nearby orchard, identify potential scion wood and graft marks and grafting onto mature trees, as well as the production of rootstocks from stools.**
- **Discuss what the cut scion should look like eg. how many buds, their position.**
- **Show several young grafted trees to explain the function of the cambium.**
- **Use pencil-sized branches of willow or apple to train how to cut leaving a large area of cambium and to wrap the grafting with different types of tape.**
- **Cut and insert a bud for bud grafting – best done in mid/late-summer.**
- **Make the simplest whip and tongue graft of rootstock and scion.**
- **Look at a small range of alternative grafts – with video and diagrams and discuss what is the best time for which kind of graft.**
- **Explain how rootstocks can be propagated in generative or vegetative ways.**
- **Purchase and care for grafting tools and equipment and their safe handling.**
- **Demonstrate or discuss typical mistakes that should be avoided.Pay attention to safety.**
- **Use sharp knives, put on a protective apron and keep finger plasters ready.**
- **Exchange experiences amongst participants.**

Aftercare of grafted trees

Care of young grafted trees

- Normally bench grafted trees are planted in a pot and bud grafted trees are planted in a nursery plot. Add a label and tie the tree to a stake.
- Regularly remove any side shoots especially on the rootstock so that the top leading shoot develops well. This tender shoot could be tied to a small stake.
- If the grafting was at the height of the crown, keep all 3 or 4 growing branches. If the grafting has to make a trunk, only accept the top shoot until it reaches the

desired height.

- Any covering material such as grafting tape or plastic film could be removed once a strong callus has formed, after 3-4 months. This prevents the grafting point from becoming constricted.

Maintenance in the tree nursery

- All lower side shoots should be continuously removed to produce a trunk of the desired height up to 2 m with a standard rootstock.
- Tree ties should be checked and renewed each year. If necessary a longer stake should be used.
- Check that the trees are protected against injury from animals like voles, mice, rabbits, grazing animals and machines. Tree guards of 0.5 cm wire mesh may protect the trees but also allow air circulation.
- In the first year or so grass and other herbaceous plants should be removed from the area of the tree roots to avoid competition for nutrients.
- Mulch this area (eg. with woodchips, rotted leaf litter or cardboard) to protect this area against evaporation. Remove the mulch in winter otherwise it will be a good hiding place for voles and mice.
- If dry in the summer the trees should be given additional water and organic fertilizer.
- The trunk should be guided to the desired height plus about 50 cm. It should be cut shortly above a bud to stimulate the lower buds to sprout and to make the first branches of the tree crown. To make a standard tree the first side branch should be about 1.8 - 2 m high.
- The young trees can then be transplanted to the existing or new orchard in the early winter. The roots should be planted in a hole that allows for the maximum vertical and horizontal extension of the roots.

Case studies

- Identifying varieties workshop (DE)
- Grafting workshop (DE)
- A scion swap event (UK)

Websites

- Apple and plum fruit identification – Fruit ID
- DNA analysis in UK – Fruit ID
- Visual determination of apple variety – Fruit ID

Downloadable pdf files

- Fruit tree identification – Peoples Trust for Endangered Species
- Identifying fruit buds – Royal Horticultural Society
- Brogdale National Fruit Collection – National Fruit Collection
- Basic fruit tree identification – East of England Apples and Orchards Project
- The pear in history, literature, popular culture and art – Purdue University
- Comprehensive guide to damsons - Daiv Sizer

- Guide to bench grafting – Peoples Trust for Endangered Species

Videos

- Heritage apple varieties – Cider Spectacles
- Identifying old apple varieties– European Specialists in Traditional Orchards
- Europom - Heritage apples from European countries - Europom
- Cutting scion wood – Peoples Trust for Endangered Species
- Choosing the right rootstock – Gloucestershire Orchard Trust
- Grafting by the whip and tongue method – Peoples Trust for Endangered Species
- Grafting by whip and tongue – European Specialists in Traditional Orchards
- Six different grafting techniques – Ian Sturrock
- Pruning apple trees – Seeds of Change, US
- Summer pruning of apple and pear trees – Peoples Trust for Endangered Species
- Winter pruning – Peoples Trust for Endangered Species

Part 5 - Processing and promoting tree fruits and nuts

Aim

To learn about harvesting, storing, processing and marketing tree fruit and nut crops.

This guide will help small orchard owners, managers, volunteers and trainers to find the best way of harvest, store, process and also market their products. It covers some historical methods and traditions, some simple way to process and to sell the products. It also suggests how to promote and celebrate the products of traditional orchards.

Objectives

The learner should be able to know about, understand, describe and demonstrate (in the context of their local area and country):

- How to harvest and store tree fruits and nuts.
- The traditional processes, products and culture and the revival of heritage foods and drinks.
- The science behind different methods of preserving tree fruit and nuts from fungal/bacterial spoilage.
- The science behind fermentation and acetification.
- How to process and preserve tree fruits and nuts - The different methods and technologies by drying, juicing, pasteurising, pickling (vinegars), sweetening (jams and desserts), fermenting (cider and wine) distilling and bottling - using both traditional and modern methods.
- The health, safety and legislative aspects of preserving and processing tree fruits and nuts with a range of equipment.
- How to promote and market tree fruits and nut products based on the 5Ps of marketing - Product (quality, packaging, labelling, certification), Place (different places from which to sell and points of sale), Price (accounting, competitors, differential pricing), Promotion (customers, places and methods of advertising) and Partners (other producers, cooperatives or enterprises).

Optional training approaches

Arrange a room at or after harvest time, with tables, preserving equipment, different fruit and nut crops, and samples of processed products to describe, demonstrate, discuss and practice:

- Comparing large-scale industrial processes with more small-scale traditional processes - using video and case studies.
- Demonstrating small-scale processes and equipment for drying (solar and electric), mashing (manual and electric), juicing (range of presses), - using videos and case studies.
- Considering additional clarifying and stabilising processes for liquid products.

- Mashing and pressing fruit to produce juice.
- Displaying and tasting different products – using blind tasting to describe and compare the experience of different participants.
- Exchanging experiences among participants.

Visit a small-scale producer and processor to describe, demonstrate, discuss and practice:

- Testing for ripeness, picking and storing times.
- Demonstrating or practicing any of the many processes with a range of simple mechanical or larger scale electrical equipment.
- Discussing levels of supply and demand, marketing, general history, management and future of the enterprise.

Arrange a room, at any time, with tables, an experienced producer/ promoter, promotional literature, internet access and processed products to describe, discuss, design and practice:

- Developing an action plan for marketing the participant's tree fruit and nut products.
- Planning and designing labels and packaging (Product), places to sell (Place), other prices eg. from internet (Price), key customers and matching advertising (Promotion) and others with whom to market (Partners).
- Using SWOT analysis of Strengths and Weaknesses of a product, and Opportunities and Threats for its marketing.
- Exchanging experiences amongst participants.

1 Harvesting and storing orchard fruit

Traditional harvesting

The traditional methods of harvesting have been well adapted for small farms and very local markets. In the past family farmers have had time to harvest from fruit trees by hand with help from the whole family and neighbours. Like many agricultural activities this helped to build and maintain the sense of local community and local pride in the orchards and their products. It also reinforced a community understanding of how to judge the best times and methods of harvesting, as well as the different fruit and nut processing methods. Tools, knowledge and labour were all shared by family farmers and smallholders within the local community reinforcing the shared heritage of local orchard culture.

Nowadays this sense of community has been re-created as the recent revival of traditional orchards has developed in many European countries. Groups of volunteers, often associated with community orchards, are again researching and adapting the traditional approaches to managing orchards.

Harvesting fruit

- Test the ripeness of the fruit suitable for different processes and products. Fruit can be misshapen, overripe, and bruised for making juice, jams, pickles etc.
- A simple method for testing ripeness is tasting the fruit, seeing ripe fruit fallen on

the floor, being able to remove the fruit by gently twisting, and a ripe colour to the seed and fruit.

- A more technical method for testing ripeness is to use a Brix Refractometer. This measures % sugar in the fruit as Soluble Sugar Content (SSC or Brix). It indicates sweetness and harvest time. When light passes through a sample containing dissolved solids (such as sugars), it is interrupted, slows down and is bent or refracted. This change in the refractive index, or bend of light, is correlated to the % sugar.
- The time of ripening is also worth recording as an annual reminder and interesting comparison related to climate change.
- Gathering the fruit can either be done by:
  - picking by hand using a shoulder-strung fruit basket
  - Gathering overripe, fallen fruit.
  - Beating the tree (usually for standard apple, perry pear or cherry trees) with a long pole (traditionally called a panking pole in the UK) and collecting the fallen fruit on a large sheet under the tree.
  - Some mechanical methods (eg. Rollblitz) have recently been popularised.
- Depending on the process the fruit can then be put into buckets, wheelbarrows or trailers for juicing etc. or into wooden/ cardboard boxes or trays.
- Nuts can also be gathered or picked in basically the same way.

Storing fruit

All fruit and nuts can be stored for a short time, especially in conditions of constant, controlled temperature and moisture. Ideally fruit should be stored in a dry, cool, ventilated store without direct contact with other fruit.

- Traditionally fruit was stored in dry and ventilated cellars or fruit stores on wooden slats or in wooden/cardboard boxes or trays. The fruit, especially apples, pears, quinces and medlars, could be wrapped in newspaper or laid on a bed of hay or sieved ash without the fruit touching other fruit. Nuts were often stored dry in bags and hung from the ceiling or stored in jars of various oils.
- Traditionally varieties that had good keeping qualities (eg. greasy, thick skin with apples) were favoured and selected. Some heritage varieties of pears could keep well until after the New Year and apples could keep for at least half the year until April. Nowadays many consumers do not realise that tree fruit is seasonal!
- Ethylene gas is naturally produced by fruit as a plant hormone that causes ripening. So reducing the spread of the gas (eg. by wrapping in newspaper) can slow down ripening. A new synthetic chemical created in 1997 called 1-methylcyclopropene (1-MCP) has also made its way into storage chambers and ships over the last two decades. It blocks the ripening effect of ethylene so together, low oxygen and 1-MCP can keep fruit in stasis for more than six months.
- Commercially the long storage life apples and pears enables them to be shipped around the world. However this uses large amounts of fossil fuel and electricity and so can considerably impact climate change, as well as affecting the scent and taste of the fruit. Locally grown and seasonally consumed fruits avoid this global shipment.
- As always with the management of fruit and orchards recording and labelling is very important. Each year more can be learned from the previous year about the

different qualities of the fruit that is stored and the storage conditions.

2 Preserving fruit

Tradition and heritage

Revival of interest - Faced with speedy supermarkets, fast foods, and quick recipes, customers are increasingly turning to small-scale, local producers and processors. They are demanding alternative and traditional products and recipes.

Valuing tradition and heritage - Artisan producers, traditional processes and ingredients and heritage varieties are now being more valued and treasured as high quality foods and drinks. This has been very noticeable in the drinks industry, where the market has moved towards craft ciders, traditional juices and hand-crafted teas. Over recent years the large-scale producers of the food and drink industry has embraced the trend for their products to be recognised and labelled as traditional. This is an increasing challenge for the small-scale artisan producer.

Science of preserving fruit

Preserving fruits, like all food and drink, is a continual battle against the bacteria and fungi which use the water and oxygen causing decomposition or fermentation.

So fruit can be preserved by eliminating water and oxygen and hence inhibiting or killing bacteria and fungi:

- Excluding water and/or oxygen (by drying, dehydrating) also may increase sugar content.
- Controlling temperature (by chilling, freezing, sterilising, pasteurising) with cooling or heating.
- Using or producing vinegar (by pickling or producing vinegar) lowers the pH and denatures enzymes.
- Using or producing alcohol (by adding alcohol or fermenting or distilling) excludes water and oxygen.
- Using sugar (by sweetening) reduces uptake of water by osmosis.

Nuts are much more easy to preserve either when fully dried or immersed in oil.

Value of preserving fruit

The management of traditional orchards usually preserves the crop either as food or drink rather than fresh fruit. The crop of tall standard fruit and nut trees cannot easily or safely be picked by hand. Harvesting the crop by beating or shaking the tall trees and gathering from the ground requires the fruit to be processed quickly before the bruising becomes rot. Preserving fruits and nuts is a key element of sustainable local food production and consumption.

- It extends the fruit season by using excess fruit.
- It avoids waste of fruit by rotting on the tree or ground.
- It produces healthy food and drink in the dark winter months.
- It saves food miles by being locally produced and consumed.
- It considerably increases the financial value of the crop.

- It justifies the conservation of the traditional orchard and its biodiversity.
- It is an enjoyable social activity, often with volunteers and community groups.

3 Choosing the method of processing

There are several pros and cons of processing fruit in different ways based on the time, labour, costs, storability and marketability.

Fresh fruit

- Only takes the best quality fruit
- Not a lot of labour (sorting)
- High specific revenue
- Simple marketing (unpacked)
- No machines

Juice

- Easy to harvest
- Big specific revenue
- Simple marketing as bag in box

- Machines necessary
- Storable product

Wine and cider

- Easy to harvest
- Very high revenue
- Expensive bottles required
- Machines necessary
- Storable product

Dried fruit

- Easy to harvest
- High revenue
- Easy marketing
- Drying apparatus necessary
- Storable product
- Lot of labour
- Lot of electrical or solar energy

Jam and puree

- Easy to harvest
- High specific revenue
- Glass containers easy to sell
- Apparatus required
- Storable product
- Regulated product

Vinegar

- Many additional flavourings
- High revenue
- High labour
- Expensive bottles required
- Storable product

Brandy and other spirits

- Highly regulated production, with legal limits
- Expensive, complex equipment
- Very high revenue
- Storable product

4 Methods of processing fruit

Drying

- For plums, apples, apricots, peaches, walnuts, cobnuts
- To produce apple crisps, chips, prunes, raisins etc.
- By oven, solar dryer, electric dehydrator and apple core-peeler-slicer

Fruit chips or crisps are now very popular with consumers as it is very healthy and a child-friendly alternative to salty potato crisps. It can be stored indefinitely in jars and used as sweet snacks. This old product now has a new image.

Oven drying

Drying by the heat of the fire is widespread in all European countries - in the oven or hanging in front of the fireplace - apples, pears, plums and apricots. This method of drying is still very valid and widespread, especially drying in dedicated ovens. Drying in a wood-fired oven, is more climate-friendly than an electric dehydrator. The technology is very simple and could be developed by smallholders and orchardists.

Solar drying

Traditionally the drying of summer fruit in the Mediterranean area took place mainly in the sun. Pears and apples were dried on stones. In Poland in the past pears were dried in bread ovens or in the sun on sieves. Now with solar driers the generally short shelf life of apples, pears and plums can be prolonged.

Electric dehydators

In more northern countries electric driers with multiple trays are becoming more popular. Food desiccators have 4 – 9 trays which can be loaded with sliced fruit. Apple rings can be produced using an apple peeler-corer-slicer. Plums can be cut in half and de-stoned. 15 hours of drying at 60 deg C should produce apple chips that can be snapped!

Pureeing

- For apples, pears
- To produce apple butter, fruit leathers
- By gently heating over oven, or paddle stirring over fire

Apple butter - In parts of Brittany, Normandy and the US some communities still make apple butter communally and very sociably. They add whole clean ripe apples to a cast iron pot over an open fire. A long handled wooden paddle is passed from person to person as they stir the bubbling apples overnight, singing songs, playing music and of course drinking cider.

Fruit leathers - Apples and any fruit can be dried to make fruit leathers. The fruit is peeled, de-stoned and cooked to a soft pulp. It is then thinly laid on greaseproof paper and slowly dried until brown and leathery in an oven at 60 deg C. It can be cut into strips and rolled into a fruit bar.

Juicing

- For all pome and stone fruit

- To produce fruit juice
- By milling, squeezing, and possibly clarifying the juice

The most popular fruit tree product is often the fresh juice. In northern Europe there is a great tradition of juicing. This is then often made into an alcoholic drink such as cider perry or wine. Pasteurised juice is now very popular and often marketed by small-scale producers and community groups.

Juice can be produced by different methods:

Bashing – Pome fruit can be crushed by pounding them in a strong, deep plastic bucket (or trough) with a clean length of timber (beetle) crushing about two layers of fruit. This is a heavy, labour-intensive method but can be social with several people holding the basher.

Pressing - This is the main traditional extraction method used for both juice and cider or perry. It requires a mill or scratter to chop the fruit into small pieces and then a basket or frame press to extract the juice. In many ways it is similar to the traditional bucket pressing of wine. This method retains the smell and nutritional value of the fresh fruit, because the juice is extracted without heating.

Steaming - This is a labour-intensive and time-consuming method but it produces a lot of clear juice. Wash and cut fruit into pieces. Put the fruit into a steam juicer (eg. Scandinavian Mehu Liisa). Bring the water in the bottom pan to a boil and allow the steam to build up. The steam and heat extracts the juice from the fruit and the juice drips into the collecting pan.

Pasteurising and Sterilising

- For the juice of all pome and stone fruit
- To produce pasteurised or sterilised juice, but the flavour and vitamins change!
- By pasteurising at 70 deg C for at least 30 minutes but this only kills pathogenic bacteria not all spoilage bacteria

Fruit juice obtained by the juicing methods above can then be pasteurised or sterilised. Pasteurisation is easier that sterilisation and the pasteurised juice can keep for several years. Clean bottles of juice of the same height are immersed in a heatable water bath. Electric pasteurisers can also be used.

Fermenting

- For all pome and stone fruit
- To produce wines, cider, perry, pommeau
- By mashing and pressing to produce juice and using yeast on the fruit or adding

yeast in pressurised containers or barrels, using equipment like fruit mills, presses, hydrometers etc.

The fermentation of fruit occurs when yeasts produce enzymes which convert fruit sugars to alcohol. Yeasts occur naturally on and in tree fruit so fermentation can occur naturally. More usually cultivated yeasts are added to fruit juice.

Traditionally the fermentation of pome and stone fruit has been much more popular in northern than southern Europe. Without the fruit of the grape, northern Europe has concentrated on cider, perry, fruit wines and their vinegars.

Adding alcohol

- For many fruits and nuts
- To produce many named alcohols (eg. English sloe gin), often with added sugar (eg. German Rumtopf with timed seasonal layers of fruit in rum and sugar)
- By steeping in bottles and jars with added sugar

Distilling

- For many fruits and nuts eg. apple, plum, hazelnut
- To produce many locally named, high alcohol drinks eg. apple brandy
- By heating in an alembic still or distillery

This is the most complex of the processes but yields the most profitable product. Southern and eastern Europe has particularly concentrated on the distillation of fruit such as sour cherries and quinces. However it is covered by strong legislation so it cannot be easily produced for market. Also large quantities of fruit are needed for distillation so selling the fruit directly to the distillers may be more economical.

Acetifying

- For many pome and stone fruits
- To produce flavoured and balsamic vinegars eg. with flowers, herbs, spices, roots, soft fruit etc.
- By exposing cider or fruit wines to air and using mother of vinegar

Acetification converts alcohol to acetic acid or vinegar making wines or cider acetous or sour. Mother of vinegar is a pale gelatinous substance composed of a form of cellulose and acetic acid bacteria (Acetobacter spp) that develops on fermenting alcohols. It contains enzymes which turns alcohol into acetic acid with the help of oxygen from the air.

Pickling

- For plums, apples, young unripe walnuts etc.
- To produce pickled fruits and nuts, pickle or chutney
- By heating with cider or wine vinegar, pickling spices and herbal flavourings

Washed and cut fruit is packed into pickling jars. Heated vinegar or brine is poured over the fruit in the pickling jar. Lastly fresh and dried spices, herbs and other flavourings can be added.

Sweetening

- For many fruits and nuts
- To produce fruit jams, jellies, cordials and preserves, or to produce honeyed nuts
- By heating with added sugar or honey using a jam thermometer, or just adding to honey (eg. with walnuts, hazelnuts)

Bottling and canning

- For many fruit
- To produce bottled or canned fruit in water or sweetened water
- By sterilising at 100 deg C kills all pathogenic and spoilage bacteria
- By heating to destroy all the moulds and bacteria in the air, fruit or water in the bottles or cans. Then the air is excluded during sterilization and the bottles or cans are completely sealed by vacuum.

Chilling or freezing

- For all fruit and nuts
- To preserve indefinitely, but the quality deteriorates
- By cellar, fridge or freezer

Fresh fruit juice will keep in a refrigerator for a few days before it begins to ferment. Freezing is not recommended as it uses a lot of electricity and so has a huge impact on climate change.

5 Marketing orchard fruit

There are many economic, social and legal conditions to consider when planning to market fruit and nut products. A variety of products can be developed by the single or community producer. However they need to be well marketed so that the right products are sold at the right place, at the right time, in the right way and at the right price.

The 5 Ps of marketing

- **Product** - Quality, variety, packaging, labelling and certification.
- **Place** – Location and point of sale.
- **Price** – Competitors, differential and comparative prices.
- **Promotion** - Customers and advertising.
- **Partners** – Other producers or enterprises with whom to market.

Product

- Fruit quality is the key to retaining customers.
- Offer many different species of fruit with most harvested from own orchard and processed by the orchard group or grower.
- Focus mainly on apples, pears and plums, as known foods, with known recipes

etc.

- Always have some specialities for sale such as winter pears, mirabelle plums or quinces.
- Always have juice and dried fruits for sale for regular customers.

Labelling - Labelling the orchard product is crucial to successful marketing. The label has to be informative, clear and honest. All the information should include the product, the production process and chain as well as the price. Additional information, perhaps on a poster, postcard, leaflet or website could include a story about the place of production, the traditions and variety, some recipes, and also the face of the orchard group or grower!

Legally required information may include ingredients, weight, nutritional value, certification (eg. organic, bio) and place of production.

Place

Location - There are many places where fruit can be marketed:

- Farm shop especially if near a major road or town.
- Mobile shop if in a remote rural area.
- Traditional market if market pitches are available.
- Special market especially from July to March, at Christmas and Easter.
- Self service at the gate in a boxed unit in view of buildings and with a safe money box.

Point of sales – The orchard fruit and products can be displayed and set up for sale in a quick, efficient and attractive way.

- Table
- Sale boxes
- Bags
- Balance
- Signs
- Cashbox
- Umbrella
- Advertisement (blackboard)

Price

Conditions – Setting the right price at particular times and locations is a key to making sales.

- Location of sale – The right site in terms of cost, competition and footfall.
- Permit – Some locations charge for a pitch.
- Personnel – Volunteers or paid staff trained to make sales.
- Products - The right product at the right time and location.
- Storage space – Space to store before and after at the point of sale.

Analysis of market – In order to select a realistic price several factors have to be researched, tested and reviewed.

- Potential number of customers – How many potential customers?
- Catchment area – How far will potential customers travel?
- Competition – What else will compete with this product at the same time?
- Products – What was the full cost of production in terms of labour and other resources?
- Sales potential – How many sales could be made?
- Return – What is the potential cashflow and profit?

Promotion

Events - Many kinds of traditional and new events can promote local orchards and their products. Local communities traditionally organised feasts and festivals dedicated to single local and seasonal fruits or traditional local products.

- Annual Days – Orchard Blossom Day, Apple Day
- Fruit displays, exhibitions and competitions of different fruit varieties
- Open days, Blossom Day picnic or breakfast
- Trails – eg. Normandy Cider Trail
- School education and competition
- Orchard visits by primary schools with parent helpers

Customers – An important part of promotion is to identify the key customers – perhaps for particular seasons or in particular locations. Key customers may often be older women. Consult, discuss and recommend fruit varieties and recipes to customers. Consider producing a leaflet or webpages with recipes and information. The health and medicinal market is growing rapidly. Some particular fruits such as sour cherry and some apple varieties are demanded in small quantities but high quality.

- Farm visitors
- Community farm members, volunteers
- Traditional market visitors
- Visitors to special markets eg at Easter, Christmas
- Restaurant and bar owners
- Public institutions, such as schools
- Delicatessens, health food shops
- Self service from the gate

Timing – The timing for sales needs to fit with time for other key tasks for the orchard owner or community.

- There are lower sales in winter.
- Friday and Saturday are the best days for sales.

- Try ways of selling in the evening.
- Promote the sale of seasonal products from July to March.

Partners

Cooperation with other partners or enterprises can share the work roles and responsibilities.

- A formal cooperative can share the purchasing, equipment, labour, advertising and selling.
- A formal contract or partnership can allow the producer and processor to specialise.
- Volunteers or share croppers can also share the work roles and responsibilities as well as the products.
- Help, exchange or bartering with neighbours can also be an informal and more traditional way of partnering.

Case Studies

- Network of small fruit juicers (DE)
- Mobile fruit juice press (DE)
- A revived local traditional product (IT)
- A revived heritage variety (IT)
- An Autumn fruit festival (HU)
- Trust Juice (UK)
- Apple Day (UK)

Pdf files

- Examining the potential for harvesting and making more use of the fruit from traditional orchards – Three Counties Traditional Orchard Project
- Making apple juice – Orchards East
- Apple juice processing technology – European Specialists in Traditional Orchards
- Processing and marketing fruit juice production – European Specialists in Traditional Orchards
- Guide to urban fruit harvesting – The Abundance Handbook
- Cider and perry in Europe – Goodfellow Publishers
- Annual cider report – Westons Cider Report 2021
- Italian grows forgotten fruit – New York Times
- Example of PGI for perry pears - DEFRA

Websites

- Processing apples to make juice, cider, cordials, jellies etc – Vigo Presses
- Juicing equipment hire – Apple Cottage Cider
- EC Quality schemes explained – European Commission

Videos

- Harvesting apples – Peoples Trust for Endangered Species
- Harvesting, storing and processing apples – Grow Veg
- Producing Trust Juice – Trust Juice
- SONNE mobile apple press – CORE Project
- Small-scale cidermaking – CORE Project
- Home-made cidermaking – CORE Project
- Hungarian fruit tree harvesting - Emil Kukoricza