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Efficient Exploitation of Local Fruit Resources Through Sustainable Production and High Added Value Processing

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Abstract

Fruit production in Europe has a dual system organization: an industrial type with high density planting systems in large extension farms and a small size orchard type in family owned farms. Certainly, the two systems are quite different in terms of fruit varieties, planting systems, orchard management and fruit production valorisation. In recent years, the smart family fruit farms became more and more important for the rural economy by increasing the efficient use of local resources, by offering social security and comfort and by reducing the environmental fruit finger print. Besides the already existing orchards, new ones are planted with trees produced using local species and varieties, better adapted to soil and climate conditions, grafted on resistant rootstocks. Low input orchard technologies, organic fertilization and integrated pest management are generally used. Natural windbreaks and shelters, grass soil cover management are generalized in order to ensure a higher biodiversity and the protection of wild life. Local fruits are produced in many cases under registered Protected Designation of Origin (PDO), Protected Geographical Indication (PGI), and Traditional Specialties Guaranteed (TSG). Those insure the product authenticity, a quality control system and a better marketing. Fruits are sold fresh on the local markets and in modern distribution network but also processed in the farm or in cooperative processing units. Special products are obtained following traditional recipes, some of the being sugar free, rich in vitamins, active principles and considered functional food. Continuous science and technology development brings innovation also in orchard technologies in European small fruit farms aiming to maintain their sustainability and competitiveness, by producing top quality fruits, with nearly to zero residues and no environmental negative impact. The European model of small smart fruit farms could be introduced and tested to Indonesian condition.

Keywords: small smart farms; local varieties; planting systems; sustainable orchard management; plant protection; local fruit processing.

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1. Introduction

The European fruit industry is a relevant sector of the EU agroindustry as, with less than 3% of total land use, it produces around 17% of the value of the total EU agricultural production. The combined fruit and vegetable sectors involve about 1.4 million farm holdings, with a total chain turnover of about 120 billion euro [1]. Fruit production in Europe has a dual system organization, an industrial type with high density planting systems in large extension farms, and a small size orchard type, in family owned farms.

Certainly, the two systems are quite different in terms of fruit varieties, planting systems, orchard management and fruit production valorisation. In both cases, the valorisation of favourable local soil and climatic conditions and the application of supplementary technological measures as irrigation and fertilization, have a positive role on fruit production level and quality and by consequences, on orchard efficiency and sustainability [2].

Local fruit varieties and populations are better adapted to a certain environment and have the capacity to better use the available resources [3]. In the same time, they are known and preferred by the local consumers. There are still many things to do in order to reach the goals of "0 kilometres food supply" and to eliminate the absurd transports from the production places to the processing units and back to the consumers [4].

The most interesting trend of the fruit production in Europe is related to the constant increase of the integrated and organic producing areas. Both systems bring a significant contribution to the sustainable development, stimulate the economic activities by the significant added value and the premium prices of the certified products [5]. Beside the agricultural land, the urban and peri urban areas are more and more studied as possible food suppling zones. Fruit with high nutritional value and sanogene characteristics can be produced on limited space in a sustainable way [6].

2. Family fruit farms potential

In recent years, the smart family fruit farms became more and more important for the rural economy by increasing the efficient use of local resources, by offering social security and comfort and by reducing the environmental fruit finger print [7]. Smallholder fruit farmers are extremely important for the economy of the agriculture and food sectors in many countries [8]. In some ideal situations, fruit farmers are associated in cooperatives that are dealing with the most important and difficult phases of the fruit industry: inputs aquisition, storage, packaging and selling. In this case, the efficiency of the fruit valorisation and farmers income are generally high.

Unfortunatelly, worldwide, most of the fruit producers are not organized and their production and sustenability are constantly under the threat of climate change effects

and market instability. Despite that, they have an important economical an societal role, by providing essential food for a balanced diet. For example, there are 3.9 million farm holdings in Romania, the majority of which are Family Farms of extensive semi-natural grassland pastoral systems and mixed farming systems, including fruit production. These semi-natural small-sale farmed landscapes are of significant economic importance. The 1 million holdings between 1-10 ha (3.1 million ha, 20% of Romania's agricultural area), are classes as semi-subsistence farms producing for home consumption, local sales and for their extended families [9]. Yet these farms are estimated to produce 25-30% of national food consumption [10].

Small-scale family farms are in many ways more productive than larger industrial farms, when all products are taken into account, for a variety of additional benefits such as food security, rural vitality, resilience, low-carbon efficiency and agro-biodiversity [9]. Small-scale farmed landscapes are more flexible in their farming activities, adapting more quickly to climate change and environmental challenges. They are strongly associated with efficient, low-carbon short food supply chains, through local and direct sales. Family farms in Romania are an important source of agro-biodiversity: both fodder crops such as grasses and clovers, and fruit and vegetable varieties of great importance for local food security, providing high performance under local conditions and sources of resilience to climate change in the future.

Fruits and vegetables have an immense potential to contribute to this need. These crops are grown worldwide in almost all agroclimatic zones, offer diversity and variety in tastes and flavours, and health benefits [11]. The use of the local fruit species and varieties can provide solutions to many problems encountered in the fruit industry worldwide. First of all, by conserving the biodiversity in rural areas there is the chance to use and benefit from the superior adaptation and crop efficiency of the local varieties in a specific environment. In the same time, there is a local consumer preference for local tastes and an increasing demand from the visitors to find local flavours and typical products on the 0 km markets. Besides the cultivation in traditional production systems, a new tendency is to plant fruit trees produced by using local species and varieties grafted on resistant rootstocks [12], better adapted to soil and climate conditions, in sustainable and integrated orchards [13].

Small family farms can produce a huge range of fruits with high nutritional and nutraceutical value. Those products are essential for a balanced healthy died and are highly requested by consumers [14]. Berry species are more and more requested for their richness in vitamins, minerals, amino acids, active principles, especially anti oxidants [15], being considered functional food [16]. "Super Fruits" as blackberry, raspberry, blueberry [17], black and red currant [12], sea buckthorn (*Hippophae rhamnoides*), chokeberry (*Aronia melanocarpa*), honeysuckle (*Lonicera caerulea*), wolfberry/Go Ji (*Lycium barbarum*) are produced in temperate zones for fresh consumption

and processing, their cultivation being possible with high efficiency in small family farms and urban areas [6].

Continuous science and technology development brings innovation also in orchard technologies [13]. in European small fruit farms aiming to maintain their sustainability and competitiveness, by producing top quality fruits, with nearly to zero residues and no environmental negative impact [18].

3. Sustainable fruit orchard technology

There is a constant quest for the most efficient planting system and tree canopy able to valorise the solar energy and to transform it in fruit production. It is also extremely important to adapt the canopy and to find the best planting density that allows to get the best results in term of high yield and quality in different production conditions [19]. Vase-shape canopies are still used with different trees vigour determined by specie, cultivar and rootstocks combinations [20–22].

By using the new dwarfing rootstocks, simplified canopies like the Vertical axis, Central leader [23], Solaxe, extended rapidly and influenced the tree management, pruning techniques and the orchard technology. The Vertical axis system has evolved into the Solaxe training system in France, with bending of the top of the axis and by bending of the lateral branches. Renewal pruning was replaced by spurs thinning, the method being named "spur extinction" [24].

High Density Planting (HDP) and Ultra High Density Planting (UHDP) from over 2,000 trees/ha and over 6,666 trees/ha, respectively, were tested by using dwarfing rootstocks [25]. HDP and UHDP are not always feasible solutions do to the high investment cost, advanced expertise needed, high level of inputs requested, difficult adaptation dwarfing rootstocks to environment conditions, etc. One solution came from medium density plantings realized with semi vigorous and semi dwarfing rootstocks, better adapted to local soil types. New canopies are proposed, characterized by the increased number of axes in order to divide the growth energy on two or three directions.

The achieved experience in apple, pear, apricot and sweet cherry with two axes canopies, in Bibaum®, Bi-Axis [26], or with three axes canopies respectively, in Candlestick (Chandelier) [27], 3-Leader system [28] and Parallel trident [29–31] is a good starting point to implement the new vertical wall systems in medium density orchards. In berry crop, vertical canopies and trellises were extended from blackberry and raspberry to black and red currant, gooseberry, blueberry etc. to facilitate the hand picking of high quality fruits for fresh market.

Most of the trellis systems in fruit crops are reinforced in order to sustain hail nets. For many areas hail protection is a must investments to protect the yield. Recently,

the use of insect proof nets that cover all the orchard was tested, aiming the reduction of pesticides use and the fight against birds, common and new dangerous pests (*Drosophilla suzukii*). Collateral problems can appear: higher disease impact, due to the high humidity and lack of air flow, reduction of light intensity and low fruit coloration etc. Rain protection is extended for high value crops as berries and sweet cherries. Besides the normal polyethylene film and polyethylene fabric recently, special innovative, coloured films with photo selectivity are tested.

Orchard management has some other essential aspects that can be improved: tree nutrition and water sustainable management. Chemical fertilization worldwide faces some important challenges as high costs, water and soil pollution, limited availability for the future etc. Many scientists are discussing about the future problems of ensuring plant nutrients (NPK) to feed the increasing world population [32]. Low input orchard technologies and organic fertilization can be the solution for that type of problems. The use of compost, organo-mineral, organic fertilizers, green fertilizers and the grass soil cover have an important role on increasing the biological soil activity [33], accumulation of organic matter and consecutively, release of minerals for plant use.

Water can be wisely used in small fruit farms as fertilizers application media (fertigation) but also as a efficient tool to control fruit production in terms of volume and quality [34] and, the tree vegetative growth. For example, water stress during the differentiation of flower buds will stimulate the process and will reduce the vegetative shoots growth. In the same time, it is essential to apply water conservation techniques and to use efficient irrigation methods during the drought periods.

Increasing agricultural production and resilience can be possible by offering improved agro-meteorological services [35] that are essential for forecasting the climatic accidents (storms, heavy rain, hail, late frosts, drought etc.) that could influence negatively the crop. In the same time the climatic data are useful for plant protection computer programmes for disease and pests management.

Small fruit farms are more adapted and open to integrated pest management. Natural windbreaks and shelters, are generalized in order to ensure a higher biodiversity and the protection of useful wild life. The protection of insectivore and pray birds that can be used on the biological fight against pests, is an important measure that consist in the installation on artificial nests, feeders and in the reduction and elimination of toxic pesticides [36]. The eco-sustainable use of pesticides, biological control of pests and diseases and the integrated and organic crop protection are important ways to reduce the negative impact of the fruit production on the environment and to ensure the reduction of fruit residues to zero [37].

4. Fruits valorisation

Fruits produced in small farms are generally sold fresh on the local markets and the access to the modern distribution network is rather impossible because of the low volumes, lack of storage, grading and packaging systems and facilities etc. High fruit perishability, in this situation, leads to high levels of physical and economical losses. Local communities and producers' groups need to use local and attracted resources to develop local storage and processing facilities to reduce post-harvest loss, preserve products quality and get added value, by processing a certain fraction of the fruit production.

Special products as fruit juices, preserves, jams, combined dried fruits, sweets, cakes etc. can be obtained following traditional recipes, some of them being sugar free and all, rich in vitamins, active principles and considered functional food. An economic way is to use renewable energy systems, and for example, sun dried fruits can be produced without big investments in most of the fruit production area [38]. More innovative processed fruit and fruit products destined to specific consumer segments: young, elderly, overweight, diabetics etc. can be produced.

Nano encapsulation of bioactive components for enhancing functional properties of fruit juices and purees; flash vacuum expansion in fruit processing for juice and puree; membrane technology in concentrated juice production; non-thermal fruit products preservation (high hydrostatic pressure, pulsed electric field, ozonation, ultrasonication); edible coatings to prevent browning, microbial decay and losses of bioactive components and to enhance texture and sensory properties of ready-to-eat cut fruit; utilization of fruit processing wastes for industrial raw materials and biogas production can increase the consumption of EU fruit and fruit based products [1].

Another important and necessary step is to develop appropriate distribution and marketing concepts in order to meet both demand and supply market requirements and educate consumers on the value of smallholders and family-farming products. o km concept and farm fruit stores, can help the local producer to increase his profitability and are useful and efficient solutions to supply the local community and other consumers with fresh, healthy and convenient products that are essential for a balanced diet. In Europe, local fruits are produced and sold, in many cases, under registered Protected Designation of Origin (PDO), Protected Geographical Indication (PGI), and Traditional Specialties Guaranteed (TSG). All these marks insure the product authenticity, a quality control system and a better marketing.

The efficient exploitation of local fruit resources needs a coherent strategy created at the community and local government levels, based on an active communication and involvement of all the actors of fruit chain including producers, marketers, distribution chains, research and education institutions, consumers etc [39]. Furthermore,

the upgrading strategies need to allow for a "sustainable intensification" [40] which means that more food can be produced on the same amount of land while at the same time reducing the negative environmental externalities [41–43].

European fruit production systems that contribute to the preservation of the environment through the adoption of an array of eco-innovative technologies delivering better products and reduced wastage under threats from climate change and limited natural resources [1], could be introduced and tested to Indonesian condition. EUFRIN (European Fruit Research Institutes Network), that recently launched the Strategic Research and Innovation Agenda for the Fruit and Vegetable Sector, in cooperation with AREFLH (Assemblée des Régions Européennes Fruitières, Légumières and Horticoles) and FRESHFEL (European Fresh Produce Association) [44] can be a active partner to provide expertise, knowledge and to participate in common research and development programs in fruit.

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