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Review on status of temperate fruit production: In case opportunities and challenges of temperate fruit production

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Abstract
Temperate fruits are those grown naturally in Mediterranean climate as they need chilling temperatures for their best performance and quality. This review paper is designed to review the production of temperate fruits and their opportunities and challenges for their production. Production of Temperate fruit needs unique environmental condition found in Mediterranean regions. This area includes California (USA), southern Europe, Turkey, Northern Africa, and Middle East, portions of Australia, Greece and Central Chile. In Ethiopia its productions are at infant stage in terms of distribution, area coverage, yield and quality. Mainly it is restricted to areas like Bonke, Boreda and Chencha, Debre Birhan, Agena and Degem in Ethiopia. However, there is the opportunity to expand and produce in the rest highland areas of Ethiopia. Lack of chilling condition (low temperatures) for their successful growth and flowering, changing of climate inefficient organized policy for the growing and supply of health and quality fruit cultivars, lack of awareness of importance and management of the fruit and disease such as crown gall, powdery mildew, scab and peach leaf curl are considered as the major challenges and limiting factor for production of temperate fruits in Ethiopia. Generally, it is important to develop cultivars adaptable to mid altitude areas to share economic importance and advantage of temperate fruits.

Keywords: Chilling temperature, climate, constraints, cultivars.

1. Introduction
Temperate fruits are those grown naturally in zones having Mediterranean climate as they need chilling temperatures for their best performance and quality. Globally areas like California (USA), Greece, Northern Africa, Turkey, Middle East, southern Europe, and portions of Australia, Centeral Chile and southern tip of Africa (Retamales, 2011) [33] are potential areas for temperate fruit production. Moreover, they can also grow in tropical highlands where temperate climate prevails (Yilma, 2014). The most economically important temperate fruits are belongs to Rosaceae family and includes peach, pear, cherries, almond, apple, apricot, plums, raspberries and strawberries (Ferree and Warrington, 2003) [18]. Among these, Apple is the dominant temperate fruit with greater than 71 million tonnes of global production. It was perceived as native to Central Asia and now grown in many countries across the world (Janick *et al*., 1996; FAO, 2009) [17, 23].
Apple, pear and plum are among important crops used for food security and income generation in other African countries, however, they were not well recognized fruits in Ethiopia (Tewoflos and Vigand, 1995) as cited by (Yilma, 2014). About 60 ago, apple was introduced to Ethiopia particularly around Chencha by Missionaries and planted in Chencha Kale-Hiwot Church garden. Nevertheless it was recently, the crop is viewed as valuable and its production has received attention as it is transforming the lives of many farmers in Chencha and the trend is expanding to the neighboring districts as well as to other parts of the country (Yilma, 2014).
Peaches and plums are among temperate fruit crops cultivated in the upland areas in small areas. This is specifically true for producers nearby urban areas. However, by now there is mindfulness of temperate fruit production among the highland societies and efforts are being taking place to expand the cultivation in highland areas by NGOs, government and private sectors (Melke and Fetene, 2014) [28]. MoA (Ministry of Agriculture) lamented that the potential areas for temperate fruit production are located in the uplands of Ethiopia remains uncultivated (Amanuel, 2015) [1].

In Ethiopia, the major temperate fruit producing areas are Chencha, Boreda and Bonke in south, and Debre Birhan, Degem, and Agena. So far, there is no data on the areas occupied and production and productivity of temperate fruits in Ethiopia (Melke and Fetene, 2014) [28].

Despite of the culture is novel to the farmers/fruit growers and is restricted to few areas in the highland, temperate fruit production in Ethiopia is promising. Its expansion is not yet well united to agriculture in-terms of use of water, land, labor, etc. Unlike in the case of cereal crops, experience in growing, post-harvest handling, marketing of the fruit and usage is minimal (EIAR, 2005) [11].

In Africa, Ethiopia have huge potential for the production of different cultivars of horticultural crops. The country is endowed with wide altitude range, weather, adequate available water and suitable land which were still not fully utilized (Ethiopia Horticulture Development Agency, 2012). From all these points, Ethiopia has some potential for temperate fruits production to contribute to economic development and poverty alleviation by improving the living standard of the poor farmers in addition to the environmental sustainability aspects (Yilma, 2014).

Despite all these production opportunities, the area occupied by fruits (tropical, subtropical and temperate) is small and mainly smallholder based due to availability of inadequate chilling condition, shortage of technology and research, lack of awareness on management of the fruit and importance, disease and pests. Ministry of Agriculture and Rural development (MoARD, 2005) [29] reported, more than 3 million farmers were participated in production of fruits on the total area of 43,500 hectare and produced about 261,000 t annually. Nevertheless, not greater than 2% of the produce is exported (Joosten, 2007) [24]. Less percentage of export from the total production is due to focus of the production on unimproved cultivars which are also poorly handled and are mainly for household consumption. These fruits are normally cultivated for the increment of household income besides of their main crops (Joosten, 2007) [24]. Generally, this review Paper is designed with the objectives of to review status of temperate fruit production, opportunities and challenges.

2. Literature review

2.1 Temperate fruit description and ecological requirements

Production of Temperate fruit wants unique agro-ecological conditions resembling of areas like California (USA), Northern Africa, Greece, Middle East, southern Europe, southern tip of Africa, portions of Australia, Central Chile and Turkey (Retamales, 2011) [33]. Apple (*Malus* × *domestica* Borkh.) is perceived as native to Central Asia is well known and leading temperate fruits and the fourth vital fruit crop following citrus, grapes and banana. It is one of important fruit crops cultivated in temperate regions and other highland areas of the world (Ferree and Warrington, 2003) [18]. It belongs to the family of Rosaceae. This family comprises different well-known genera and economically too important fruits such as almond, peach, apricot, pear, plums, apple, strawberries, cherries, and raspberries. Of all these, apple accounts about annual production of 71 million tonnes, and considered as the leading temperate fruit (FAO, 2009) [17].

About 60 years ago, apple was introduced to Ethiopia by Missionaries and established at Chencha Kale-Hiwot Church garden. However, it was recently viewed as valuable and its production has received attention due to transforming the lives of many farmers in Chencha and the trend is expanding to the neighboring districts as well as to other parts of the country. Following the expansion of its production in Chencha and other areas, there is a growing demand for apple in central Ethiopia. The country has also a potential to export apple, if production and quality is further improved (Yilma, 2014).

Most temperate fruit trees needs chilling temperature during the winter time to break bud dormancy ahead of active shoot growth in the spring (O'Rourke, 2003) [31]. In general, temperate climate region is suitable for growing apples and other temperate fruits. Also, apples can be produced in subtropical region and even under tropical areas at high altitude where two crops are grown per year. As an indication, India is the largest apple producer in the tropical and subtropical areas (Pereira-Lorenzo, 2009).

In Ethiopia, production of temperate fruit is promising even though it's new to the farming society and is restricted to few upland areas. Its expansion is not well integrated in-terms of use of water, land, labor and knowledge in management, handling, consumption and marketing. From the different observation, varietal evaluation and selection conducted in Ethiopia, promising apple cultivars: Anna, Golden Delicious, Red delicious Gala, Winter-banana, Granny smith, and Crispin were identified. Furthermore, peach cultivars like McRed, Florida Bell, Florida Red and plum cultivars: Shiro, Methley and Beauty were identified for production in central highland areas of the country (EIAR, 2005) [11].

2.2 Temperate fruit production status

Temperate fruit crops reached 23.5 million hectares until 2009 cropping year on the world. Meanwhile of 1961-2006, there was an expansion of temperate fruits in terms of area coverage, with greatest increment for plums (446%) and blueberries (582%). Also, strawberries (180%), apples (182%) and peaches (164%) were the species with slowest expansion. In the case of apple, despite the radical increment by 35% in 1986-1996, it was reduced by 24% from 1996-2006 (Retamales, 2011) [33].

Identifying great producer and exporter country and countries have been gaining greater market share in a recent period is important. Thus, Mexico and South Africa are the second fruit exporting countries with each 5-10% share of the global market. The third set of countries in descending order includes New Zealand, Argentina, Turkey, Colombia, Philippines, China and Brazil have between 5 and 2% of global fruit market. Chile exports the huge proportion of its fruit followed by South Africa, Colombia, and Philippines with average percentage share of 45%, 38%, 25% and 17% respectively. On the other hand, countries like China, Brazil and the European Union destine > 95% of homegrown fruit to the in domestic market (Retamales, 2011) [33].

Similarly, Granatstein *et al.* (2010) [21] and FAO (2008) collected, archived and reported extensive data on production of temperate fruits crops including the other crops. Database search were used to develop worldwide trends for an estimation of world harvested area of temperate fruits along with change in percentage (Table 1).

Table 1: World area planted to temperate fruit production and changes in different periods.

Fruit crop	2006 (ha* 1000)	Changes in world area harvested (%)		
		1961-2006	1986-1996	1996-2006
Apple	4,786	182	35	-24
Pear	1,670	234	48	11
Cherry	341	265	16	-2
Peach	1,448	164	23	9
Plum	2,154	446	37	20
Kiwi	73	---	68	29
Strawberry	264	180	13	17
Raspberry	165	236	23	23
Blueberry	80	582	41	39

Source: FAO, 2008, Granatstein *et al*., (2010) [21] and Retamales (2011) [33].

An increase in apple production from 1986–1996 production year and thereafter the decrease is mostly due to activity in China. Blueberry appears the most rapidly developing fruit during the past decade due to major new plantings in the country; likely a response to the demand for high anti-oxidant foods (Granatstein et *al*., 2010) [21]. In Ethiopia, temperate fruit productions are at infant stage in terms of distribution, acreage, yield and quality. Temperate fruit producing areas like Bonke, Chencha and Boreda, Debre Birhan, Degem, and Agena, in Ethiopia are areas where the temperate fruit production was started largely. Although, statistical data were not availabe for evidence on the areas occupied and annual temperate fruits production (Melke and Fetene, 2014) [28].

2.3 Opportunities and challenges of temperate fruit production

2.3.1 Temperate fruit production opportunities

2.3.1.1 Climatic condition

Ethiopia has diverse agro-ecologies which are suitable for growing temperate, subtropical and tropical fruit crops. For instance, considerable areas in the southern and south-western parts of Ethiopia receive sufficient rainfall which can boost fruit production and productivity (Amer, 2002) [2]. Due to diverse agro ecological conditions, there is the possibility of producing different cereal and horticultural crops. There is an altitude above 2400 masl and conducive temperature ranging from freezing to 16 °C for the production of highland fruits and vegetables. Also, mid altitude areas (500–2400 masl) with day temperatures range from 16–30 °C which favours not only the production midland crops rather the possibility to produce lowland and highland crops including temperate fruits. Lastly, there is an altitude of below 1500 masl with day temperatures above 27°C (Wiersinga and de Jager, 2009) [37] in Ethiopia which indicate the opportunity of producing different crop types based on the agro-ecology.

The topographical variation ensures the presence of climatic variability which makes Ethiopia is a conducive for different kinds of crop production. Also, about 60% of the land is suitable for farming ((Berhe *et al*., 2009, Wiersinga and de Jager, 2009 and Ashebre, 2015) [4, 7, 37]. Most part of Ethiopia is surprisingly under temperate region by African standards due to its elevation (Ethiopian Investment Commission, 2015) [16].

Similarly, Ashebir *et al*. (2010) [3] suggested highland areas of Ethiopia is endowed with various soils and climate which probably favors temperate fruits production. Moreover, the country has diverse topographical structure, resources and agro-ecological groups, from which more than 50% of the total area is highland (2000–4500 m.a.s.l.). Also, there is sufficient water sources and low temperature during winter which is congenial for production temperate fruit crops.

In Ethiopia, the ultimate source of water is rainfall whereby ground water, surface water and other water sources are fed by rain. Based on grid-based mean annual rainfall and area of the land, Ethiopia receives more than 980 billion cubic meters (m^3) of rain. On the base of temperature and moisture regimes classification data, Ethiopia is classified into 32 major agro-ecological zone (AEZs). Further, these 32 AEZs can be clustered into three primary zones (Ashebre, 2015) [4]. Thus, in combination of all environmental aspects, which have positive relation for temperate fruit production, Ethiopia has great potential for temperate fruits production contribute in economic development and poverty alleviation by improving the livelihood of farmers in addition to the environmental sustainability aspects (Yilma, 2014).

2.3.1.2 Growing in low chilling area

There is possibility to grow in areas where chilling temperatures are in adequate by using different technologies. One of the possible solution is use of low chilling requirement cultivars like Anna (Cook and Jacobs 2000; Erez, 2000; Webster, 2005; Dereje *et al*., 2010) [9, 13, 35, 36]. The other possible strategy is bringing the trees into an artificial dormancy by interrupting the irrigation (Njuguna *et al*., 2004) [30]. Then after, following either manual defoliation or chemical treatment or both of them to break dormancy (Melke and Fetene, 2014) [28].

Ashebir *et al*. (2010) [3] conducted a study at Mekelle University (MU) and Hagere Selam (HS) which is tropical highlands of Ethiopia. For the experiment, He introduced Gala (Gala Must and Galaxy), Golden (Golden B. and Golden Delicious), Granny Smith, Fuji Kiku and Jonagold apple cultivars from Belgium and Netherland with other treatments. In combination with these, He used different treatments: i) Yearly defoliation; ii) Dormex 1% treatment after one defoliation; iii) for the first year two defoliations per year, substituted by defoliation and Dormex 2% application in the second year and the last was iv) control (no both defoliation and chemical treatment) as experiment one and planted in 2003. The second trial was consisted of four treatments and undertaken in 2005/6 year. The treatment details were: i) one round defoliation followed by 1% Dormex, ii) one round leave removal (defoliation) followed by application of 4% winter oil; iii) one round leave removal followed by application of 0.5% Dormex and 2% winter oil, and iv) control (no both defoliation chemical/treatments).

From the result Ashebir *et al*. (2010) [3] reported that flowers number per tree were statistically higher on Dormex-applied trees than one defoliation per year and untreated (control) trees. Also, a result obtained from winter oil application experiment was similar with Dormex treatment. However, the response of apple cultivar to Dormex and winter oil was not comparable. Jonagold cultivar showed the highest positive response to Dormex and winter oil treatment. Trees received winter oil and Dormex separately or trees treated by both of them showed bud

break and flowered earlier than control and one defoliation per year. Dormex and winter oil treatment resulted an even and high blooming in all apple cultivars. Moreover, the result indicated, the existence of variation among the cultivars on bud break and blooming. Apple cultivars treated by Dormex and winter oil showed earlier blooming and fruit setting by a difference of about two weeks.

However, the overall flowering period was still long (five weeks) when compared with the flowering period in temperate zones which is 2–3 weeks difference. Similarly, defoliation of mature leaves after harvest hinders the buds entering into endodormancy instead renders them to regrow (Tromp, 2005) [35, 36]. A Dormex treatment after defoliation and 2–3 weeks ahead of dormancy break resulted uniform blooming which in turn gave higher yield, as compared to one defoliation per year and untreated plots (control) (Ashebir *et al*., 2010) [3].

2.3.1.3 Water source and arable land

Agricultural water management and development of irrigation improves productivity and reduce vulnerability of agriculture to climatic volatility in any country (Awulachew *et al*., 2010) [5]. The surface water of Ethiopia which are coming from the country's twelve river basins are estimated to 122 billion cubic meters per year. Furthermore, the ground water sources of the country are not yet known. However, different reports indicated that Ethiopia has the ground water potential of about 2.6 billion cubic meters (Amer, 2002 and Cherre, 2006) [2, 8]. Ethiopia is endowed with fertile soil and suitable agro-ecological zones for agriculture (Table 2) that make a country the priority choice for the production of perennial and annual crops (Ashebre, 2015) [4].

Table 2: Land at bank and future potential.

No.	Development pocket	Registered land in land bank (ha)	Identified land for investment	Land for out growers scheme (ha)	Total (ha)
1	Oromia and Addis Abeba	7354	2,646	20,000	30,000
2	Bahir dar, Abbay valley and South Gonder	2000	3,000	20,000	25,000
3	Awash, Dire Dawa, Hara and Somali		20,000	1,000	21,000
4	Hawassa and Arbaminch area	3000	60,000	20,000	29,000
5	Mekele, Raya Kobo and Alamata	3000	2,500	20,000	25,500
	Total	15,354	34,146	81,000	130,500

Source: Ashebre (2015) [4].

Ethiopia has a potential irrigable area of 3.5 million ha with net irrigation area of 1.61 million ha, of which currently only 4.6 % was utilized (Amer, 2002) [2]; with existing equipped irrigation schemes covering about 640,000 hectares. This means that a significant portion of arable land in Ethiopia is currently not irrigated which is considered as feature opportunities for expansion of temperate fruits like others (Awulachew *et al*., 2010) [5]. In terms of soil fertility, most of the Ethiopian soil types are ranging from light clay to loam and are well suited for horticultural production (Ethiopian Investment Agency, 2012) [14].

2.3.1.4 Government policy and incentive

The government Ethiopia incorporated a strategy on encouraging the production of highland fruits in the country to benefit the people for ware consumption, domestic and foreign market. Thus, currently apple, peach and other temperate fruits are under experimentation in some parts of the country. The Ethiopian Institute of Agricultural Research aimed to instantly works on training of farmers to impart awareness on adapting the crops in suitable environment which may help to boost the production of temperate fruits (Girma, 2015) [20].

Investment goods imported without the payment of import customs duties and other taxes levied on imports may be transferred to investors enjoying similar privileges. Any income derived from an approved new manufacturing, agro-industrial or agricultural investment is exempted from the payment of income tax ranging from 2-8 years (Ethiopian Investment Agency, 2012) [14].

2.3.1.5 Geographical location, demand and market opportunities

Proximity of Ethiopia to international markets is an opportunity to produce temperate fruits which helps in generating foreign currency as far as favorable agro-ecology is existing. Government is investing on building infrastructure which enhance transportation and improve postharvest handling of perishable crops (Ethiopian Investment Agency, 2014) [15]. Both fresh and processed product of horticultural produces have a large domestic market in Ethiopia (which is significantly greater than the exported volumes). Ethiopian population growth is dramatically increasing, this indicates the existence of large demand for fresh fruit and vegetable crops (Ethiopian Investment Agency, 2012) [14]. Besides of a demand for domestic market, there is a demand for Ethiopian products by European countries, thus, this is a great opportunities to produce more fresh fruits and export abroad (World Bank, 2004) [38].

In order to realize cost effective, efficient and reliable import and export movement of cargo to and from the seaports of the neighboring countries, Ethiopian government has formed the Ethiopian Shipping and Logistics Enterprise (Ethiopian Investment Commission, 2015) [16]. Generally, the development of local fruit and vegetable market is a long term process rely on economic development, urbanization and consumers behavior. However, there is an import substitution of processed fruits, mainly soft drink concentrates and fruit juices in the short term (Wiersinga and de Jager, 2009) [37].

The other factors such as aging of the population, income, market promotion, and consumer wakefulness on the benefit of fruit, year round availability have attributed to the increment of fresh fruit consumption. The consumption of temperate, tropical and subtropical fruits have been increasing in the last years due to changes in consumer preferences and promotion made by international organizations and governmental agencies (King *et al*., 1999) as cited by (Retamales, 2011) [33]. Fruit processing factory into concentrate near the source of the fruit either for export market or for the local market is also an area of investment available in the country. Only, Merti fruit processing factory which is the only fruit juice processing factory for the local market is available in Ethiopia. Thus, at present, different fruit juices are imported into the country. As indicated by the fruit juice importers, the demand for fruit juices on the local market is high. This indicates the presence of investment opportunities in establishing fruit juice processing factory for the

local market (Ethiopian Investment Agency, 2012) [14].

2.3.2 Review on temperate fruit production challenges

2.3.2.1 Inadequate chilling temperature

Temperate fruits such as apple require a period of low temperatures (cold season) for their successful growth and flowering and a season of relatively high temperature in order to mature fruit of good quality (Yilma, 2014). However, absence of extended chilling temperature in tropical region extended flowering period (greater than seven weeks) and low bud break of the lateral buds which in turn reduced flower buds and fruit numbers on the trees. The clear fact that Ethiopia is in the tropical region without reliable winter season makes it difficult to grow high chill requiring apple cultivars (Dereje *et al*., 2010).

2.3.2.2 Climate change

Season of chilling temperature is highly affected by climate change (Baldocchi and Wong, 2008; Luedeling *et al*., 2011) [6]. With expected to rise of global temperature expected by up to 6 ^{0}C by the end of the 21st century, it is unlikely that this agro-climatic condition will remain stable (Luedeling *et al*., 2011). Advancing trends in bloom dates of different tropical, subtropical and temperate fruit trees indicate that dormancy breaking processes are indeed changing, most likely its due to response to climate change (Guedon and Legave, 2008) [22].

Climate change is a major threat and constraints for all crops. This has a great influence on irrigation (on water availability, quantity and quality), heat and drought stress and lack of chilling hours, input cost rising, reduced crop yields due to unfavorable weather condition, increased risks of exotic disease, pest outbreak and changes in the distribution of pests and diseases. Simultaneously, increased imports amplify the biosecurity risk of exotic pest and disease spreads (Retamales, 2011) [33].

2.3.2.3 Technology and orchard management

The major limiting factors for the insufficient production expansion and unattractive performance of the temperate fruit sub-sector are, including an inefficiently organized system to deliver improved temperate fruit varieties/cultivars. Mainly, seedlings are propagated and supplied from a few centralized government and non-government organization, which deliver subsidized seedlings to government (Berhe *et al*., 2009) [7].

Government of Ethiopia does not have the capacity to propagate temperate fruit crops seedlings and it wants investors to distribute the planting materials to farmers although no company is interested to propagate it. Additionally, works that have been done to start the preparation of temperate fruits are too small. All these in combination results farmers are not getting the seeds in the market and showing the shortage of technologies (Amanuel, 2015) [1].

Tree or fruit orchard horticultural and agronomic management practices like spacing, canopy management (pruning), training, flower and fruit thinning greatly influence not only final yield fruit but also tree vigour, growth rate, precocity, fruit size and quality. These operations are varying considerably with fruit species and cultivars, stage of tree and the type of rootstock used. For instance, pear and apple fruit trees needs light pruning type for developing the desired form of the canopy. Whereas, plum and peach, require regular topping throughout their growth cycle to promote growth. All these management practices are not adopted by temperate fruit growers which lead to poor productivity and increase the susceptibility of plants to different pests and diseases.

2.3.2.4 Temperate fruit diseases and insect pest problem

Temperate fruits are suffered by diseases and insect pests. Major temperate fruit diseases such as powdery mildew, scab, crown gall and peach leaf curl are serious problems in most of temperate fruit growing areas and become restraining the production of fruits. Fikre and Messele (2005) [19] reported that, temperate fruits in Ethiopia is challenged by apple scab, powdery mildew, and leaf curl (on peach and cherry plum). Also, to a lesser extent, temperate fruits are affected by insect pests.

However, there were no significant research works on the management of diseases and insect pests on temperate fruits. Some farmers are using various indigenous practice to manage powdery mildew and scab with a bit success. Currently, interested companies and individuals are introducing planting materials at ease. These pioneered introducing important diseases that can seriously affect all the crops grown in the lowland, midland and highland areas of the country. Moreover, insect pests such as peach aphids, wooly aphid and beetles were observed in some farms near Holetta in central highland (EIAR, 2005) [11].

3. Summary and Conclusion

Temperate fruit is belongs to Rosaceae family and includes pear, apple, almond, apricot, cherries, peach, plums, strawberries and raspberries. Apple is a dominant temperate fruit with a global production of more than 71 million tonnes. Generally, temperate fruit crops necessitates specific environmental conditions which are found naturally in around Mediterranean regions. In Ethiopia temperate fruit productions are at infant stage in terms of distribution, acreage, yield and quality. Ethiopia is gifted with various weather conditions, altitude, adequate water and availability of arable land fertile soils. This help to fruits, vegetables, root crops and cut flowers which were still at an infant stage. Additionally, the inventory of chemical usage like Dormex, crude oil and KNO_3 also provide the alternate opportunities to grow temperate fruits as they studied and showed promising results. Despite all these potentials, lack of chilling condition for their successful growth and flowering, climate change, government attention for the production and supply of improved fruit varieties/cultivars, lack of awareness of importance and management of the fruit and disease problems are considered as the major challenges and limiting factor for production of temperate fruits.

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