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Challenges for Certified Organic Banana Production in Eritrea

Yohannes Ogbalidet Drar[1,2] • Anthony Keith Thompson[1,3*]

[1] Department of Plant Science, University of Asmara, PO Box 1220 Asmara, Eritrea
[2] Present address: Ministry of Agriculture, Barentu, Eritrea
[3] Present address: Plant Science Laboratory, Cranfield University, Cranfield, Bedford, UK

Corresponding author: * **anthonythompson@onetel.com**

ABSTRACT

The objective of the work was to investigate the constraints and prospects of growing organic bananas for export from Eritrea. The Government of Eritrea has encouraged the development of the banana industry but the local market is saturated and the world market is over supplied and it is difficult for new exporters to find a lucrative market. Therefore banana production is contracting. However, there is a possible market for organic bananas and therefore a need to identify the requirements for Eritrean bananas to be certified as organic producers. As a first step to achieve this major banana producing areas of Eritrea were surveyed and 45 banana growers were interviewed. Pest and particularly disease control are usually the major challenges in organic production therefore the incidence and infestation levels of the major pests: nematodes, weevils, viruses and cigar end rot were studied. Soil samples and a water sample were collected and analyzed for their chemical composition. Results showed that on the farms studied the nematode incidence ranged 20-372/100 g fresh root weight, with 17-58 nematodes/100 g of soil. No weevils were found in all the surveyed areas. The average Banana Bunchy Top Virus incidence was 3.3% and Cigar End-Rot was 3.6%. The soil was of medium to low soil fertility but with a good texture. Water quality was found to be suitable for irrigation of bananas. The levels of these pests and diseases indicated that bananas could be grown using the system currently used by Eritrean farmers without the chemicals that are not permitted by international regulations for organic production. Some preharvest, particularly soil fertility, and postharvest practices, particularly crown rot control and harvesting and handling systems, were identified as being required to improve yield, quality and out-turn, but it was concluded that from a technical point of view organic banana production and export could be established in Eritrea.

Keywords: cultural practices, diseases, irrigation, nematodes, postharvest, soil fertility, viruses, weevils

INTRODUCTION

This manuscript examines the challenges in changing from conventional banana cultivation for local markets to organic production for export and how these can be met in Eritrea.

The majority of the bananas grown in Eritrea are Dwarf Cavendish (88%) with some Williams and Grand Naine (MOA 2002). Bananas were introduced to Eritrea from Somalia in 1945 and export began in 1964 to Italy and the Middle East with some to Ethiopia and Sudan. This export stopped in 1974 due to the war. After independence in 1991, banana production increased rapidly but export markets to Ethiopia and the Sudan were subsequently curtailed and there is currently no export. This has resulted in an oversupply on the local market and many farmers have stopped growing bananas (Ogbalidet Drar 2006).

The world banana market is very competitive and dominated by transnational companies, therefore new exporters face significant barriers to entry (FAO 2003). As a consequence one way that countries like Eritrea could enter the export market is to look for niche markets, one of which is to produce high quality organic bananas. The market for organic bananas has been increasing over the past decade in the European Union, Japan and USA usually commanding premium prices of 30 to 80% (FAO 2003a). For example the annual banana exports from Peru increased from 856 tonnes in 2000 to 64,586 tonnes in 2007, virtually all of them organic, and in value from $264,000 to $31 million (Keane *et al*. 2009). However, there are several challenges in producing organic bananas especially controlling pests and diseases. Common pests and diseases of bananas include Sigatoka leaf spots caused by *Mycosphaerella* spp., Panama disease (*Fusarium oxysporum* f. sp. *Cubense*), cigar end rot (*Verticillium theobromae*), banana bunchy top virus (BBTV), nematodes especially *Radopholus similes* and the banana borer weevil (*Cosmopolites sordidus*) (Stover and Simmonds 1987).

The objective was to investigate the challenges that an Eritrean farmer would encounter in converting from conventional to organic banana production and the processes needed to achieve this.

MATERIALS AND METHODS

The area of study was Agordet, Tessenai and Haicota, which are the major banana producing areas in Eritrea. In Agordet there are 230 banana producers from these 35 farmers were interviewed. In the Tessenai there are 25 banana farmers from which five were interviewed and in Haicota there are 10 farmers from which two were interviewed. Those interviewed were randomly selected giving a total of 42 banana farmers. For the study of banana ripening, 5 wholesalers in Asmara were interviewed. In addition to the interviews the banana production system in the Agordet, Tessenai and Haicota was assessed visually with the collaboration of the extension officers of the Ministry of Agriculture. Assessment was made of soil fertility, cultural practices, irrigation techniques, fertilizer application, weeding, diseases and pests, and postharvest handling of bananas.

From the experience of the authors and discussions with extension officers it was decided to assess levels of nematodes, banana weevil, cigar end rot and BBTV. No attempts were made to assess leaf spot and other diseases since these have never been reported by the Ministry of Agriculture or farmers. The Cavendish varieties grown in Eritrea are resistant to Panama disease therefore no assessment was made.

To assess nematodes 10 farms growing Dwarf Cavendish and

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seven farms growing a mixture of Williams and Grand Naine were selected randomly. Then 10 plants per ha in their first 14 days from flower emergence were arbitrary chosen for sampling (Speijer *et al*. 1998). From each plant, all banana roots and approximately 250 g of soil were removed from holes measuring 25 cm^3 at some 30 cm from the banana corm. The roots and soil of each plant were mixed into a bulk sample and kept in individual plastic bags and examined four days later. The method of nematode extraction was based on the procedures described by Speijer and Ssango (1990) using the Baermann funnel technique. To extract nematodes, 25 g of banana roots were washed and chopped into approximately 1cm long segments and placed in water. After 48 hrs, nematodes were counted using a compound microscope in 2 ml aliquots from 25 ml suspensions. The nematode population density was then adjusted to 100 g fresh root weight (Brooks 2004; Coyne *et al*. 2005). Nematodes were also extracted from 100 g of the bulk soil samples that passed through 8mm aperture sieve using the Baermann funnel technique. The nematode population density was then adjusted to 100 g of soil. The nematode population obtained from both the soil and root samples were transformed into 95% confidence limits ($n \pm 2 \sqrt{n}$) as recommended by Barker (1985) in order to reduce the sampling error.

In order to assess banana weevil infestation, split-pseudostem traps were used. 25cm long pieces of pseudostem were split lengthwise in two. Then they were laid flat side down in pairs on cleared soil at the base of each mat. The number of weevils was counted after 3 days (Price 1993). Mats were watered before setting, because soil moisture level is probably the most important environmental variable whose daily and seasonal fluctuations may directly affect weevil trap catches. For this assessment, 10 plants from each of the 17 randomly selected farms were examined for the weevil.

For cigar end rot and BBTV, 12, three and two commercial plantations in Agordet, Tessenai and Haicota respectively were assessed. Fifteen fruiting banana plants from one hectare were selected randomly therefore a total of 255 plants were surveyed. Random samples were collected from survey sites selected irrespective of symptoms observed. Mats with any plants showing moderate to severe BBTV and cigar end rot symptoms were considered infected. If symptoms were mild or indefinite, the mat was not counted. If all plants were without symptoms, the mat was counted as healthy. The number of healthy and BBTV and cigar end rot infected mats per commercial farm were totalled and the percentage of mats with the disease was calculated.

RESULTS AND DISCUSSION

Climate

The climate in Eritrea where bananas are grown is semi-arid with a mean annual rainfall of 350 mm, confined almost exclusively to the 3 summer months, and potential evapotranspiration is 1800 mm (MOA 2002). The mean minimum temperature is 12-30°C and the mean maximum is 32-46°C (Melakebrehan 1997). The low rainfall, low humidity and sandy soils with low organic matter in the banana producing areas are not conducive to fungal and bacterial diseases. It was concluded that the climate is suitable for high quality banana production but irrigation is essential.

Ecological factors

In relation to the requirement of organic banana cultivation IFOAM (2003) stated that "Organic farming benefits the quality of ecosystems, and operators should maintain a significant portion of their farms to facilitate biodiversity and nature conservation." According to these standards, operators shall take measures to maintain and improve the landscape and enhance biodiversity. The clearing of primary ecosystems is prohibited. Land preparation by burning vegetation is restricted to the minimum and defined and appropriate measures to prevent erosion are required.

In Eritrea all banana farms are located along the river banks where the vegetation is dominated by small bushes of *Acacia* spp., *Zizphus sphinachrist*, *Caloptropis procera*, *Balanities aegyptica* and Doum palm (*Hypenene thabaica*). As land is being proposed for agricultural use, there are certain regulations and the Ministry of Agriculture's forest and wild directives indicate the steps that should be followed to ensure agroecology and biodiversity of the proposed areas. The directives agree with the IFOAM (2003) norms and standards in managing ecosystems and biodiversity. According to the Eritrean Ministry of Agriculture directives (MOLWE 1999) no agricultural concessions are allowed in land with greater than 25% tree cover; no removal of Doum palms and other important trees from concessions granted in land with lower than 25% tree cover. At least 30% of the total cover to be left for trees, including all land within 50-100 m from river banks. No cutting of trees without license. No use of fire on farmland and no agricultural concessions within 50-100 m of tree lined banks of all river courses and springs especially flood plains. No cultivation on land over 35° slope. In order to monitor the implementation of these regulations, extension officers carry out field visits and farmers generally follow the regulations.

Social factors

The banana production sector contributes to the alleviation of unemployment and improves the livelihood of the rural communities. The workers are comparatively well paid and the employees are supported by the Eritrean labour office laws (similar to the International Labour Office convention) providing the workers with the basic human requirements. The IFOAM (2003) basic standards and norms of social justice are currently implemented in Eritrea and this regulation can pose no constraint in certifying the bananas as organic.

Conversion period

The conversion period from conventional to organic production should be long enough to improve soil fertility significantly and to re-establish the balance of the ecosystem. IFOAM (2006) states that perennial plant products shall only be considered organic when a conversion period of at least 18 months has elapsed prior to harvest. In general, for organic certification of bananas a three year conversion period is required, during which organic production methods are used but no fruit are marketed as organic. Products of farms in transition to organic production methods may be labelled as "transition to organic" after 12 months of production (FAO 2001). The transition period between conventional and organic farming practices is often marked by a decrease in nitrogen availability and in yields due to a shift in biological activity and nitrogen sources that are not immediately available for plant use (Davis *et al*. 2002).

Partial conversion

The whole farm should be converted to organic production and the conversion plan should include the steps and approximate timeframe for whole farm conversion. If the whole farm is not converted the organic and conventional parts of the farm must be clearly and continuously separated (IFOAM 2006).

Organic certification

Producers and exporters wishing to export fruit with an organic label will have to obtain organic certification. Organic certification is a procedure for verifying that the production process conforms to certain standards (FAO 2001a) and gives the right for the certification body to have unannounced inspections (IFOAM 2006). Certification can be carried out on individual or cooperative basis (Holderness *et al*. 1999). Producers wishing to enter a specific market for organic products may find it useful to be certified by certification bodies with a certification label that is well known in the market (FAO 2001a).

Soils

The soils in the banana producing areas were of good texture but low in organic matter of only 0.6% (0.2-1.6%). The cation exchange capacity was 28.71-44.37 me 100 g^{-1} soil and according to Landon (1991) this range is within an accepted level for good agricultural soils. The pH (1:5) was 8.2-9.6 and slightly saline with a sodium content of 0.55-7.19 Cmol kg^{-1} of soil. The mean phosphate level was 19.1 ppm (7.9-81.4 ppm) and potash level was 0.5 Cmol/kg (0.06 to 1.53 Cmol/kg) but nitrogen content was low with an average of only 40 ppm (10-70 ppm) (Ogbalidet Drar 2006). Stover and Simmonds (1987) quoted the lower limits of adequacy for nitrogen in banana soils to be 1200 ppm. Melakebrehan (1997) indicated that the soils in Agordet did not need potassium fertilizer application but Landon (1991) established a critical level for 'normal' soils to be in the range of 0.4 to 0.5 Cmol/kg of exchangeable potassium.

Fertilizers

Stover and Simmonds (1987) reviewed fertilizer application to bananas in several countries and showed that nitrogen was 110-600 kg ha^{-1} $year^{-1}$ phosphate 0-300 kg ha^{-1} $year^{-1}$ and potassium 0-1200 kg ha^{-1} $year^{-1}$. The low organic matter, phosphates and especially nitrogen levels in the Eritrean soils indicate the need for considerable amounts of animal manure. Chicken manure would be particularly effective. The biodegradable material of microbial, plant or animal origin produced from organic practices should form the basis of the fertility programme. Nutrient resources should be used in a sustainable and responsible manner. Nutrient losses from the farm to the natural environment should be minimized. Nutrients should be used in such a way and at appropriate times and places to optimize their effect (IFOAM 2006). The survey indicated that the use of chemical fertilizer is very low in Eritrea. In Agordet about 53%, in Tessenai about 60% and in Haicota 33% of the farmers interviewed applied fertilizers mainly urea at 150-200 kg ha^{-1} $year^{-1}$. In other banana producing areas fertilizer use is much greater for example in the Windward Islands 2700 kg of NPK fertilizer $hectare^{-1}$ $year^{-1}$is common (Reid 2000).

Organic farming requires the recycling of organic materials and nutrients. About 77% of farmers in Agordet, 60% in Tessenai and 67% in Haicota use animal manure and pseudostem mulches. Mostly the harvested pseudostems and banana leaves are discarded or burned, but this practice is discouraged. Lopez (2000) estimated that approximately 20% of the banana's potassium needs (125 kg of K_2O ha^{-1} yr^{-1}) can be supplied by banana compost. Therefore farmers need to make compost from farm residues. In Agordet about 50%, in about Tessenai 40% and in Haicota about 45% of the farmers had some domestic animals and the number of livestock was 4-5 head. As a consequence the amount of organic manure required for increasing the yield will not be attainable, unless collected from neighbouring villages or farmers keeping more animals. The animal manure collected from both the farms and neighbouring villages can be regarded as organic, since no concentrated feed is used which can impede organic certification. The amount of cattle or chicken manures widely used in some countries reached of 35-120 tonnes ha^{-1} (Martin-Prevel 2006). The standards for organic farming do not allow the use of inorganic chemical fertilizers but both IFOAM and the European Union have a list of specific recommended fertilizers and soil conditioners as well as prohibited natural inputs (FAO 2001; IFOAM 2006). No official figures are available for banana yields in Eritrea but anecdotally it is considered to be around 20 tonnes ha^{-1} $year^{-1}$. While this is a reasonable yield, if accurate, and compares with countries like Honduras and is perhaps higher than yields in Uganda, it falls far short of yields in the major Latin American producers e.g. the national average in Costa Rica is 52.5 tonnes ha^{-1} $year^{-1}$. With the scarcity of organic manures in Eritrea the yields may be unacceptably low.

Water

In Eritrea all banana production is with furrow irrigation. Water is pumped from underground and channelled along earthen channels and then between the rows. This system is wasteful of a scarce resource and converting to the more efficient drip irrigation requires capital that is currently unobtainable by farmers. It would also require training the farmers in drip irrigation techniques. Water samples taken in the banana producing areas fulfilled all the requirement criteria of irrigation water quality and would present no impediment to organic production (Ogbalidet Drar 2006). The total dissolved solids in sampled water were 190 mg l^{-1}. Ayeres and Wesrcot (1985) indicated that water with total dissolved solids of less than 450 mg l^{-1} has no any restrictions on its use. The irrigation water salinity of Ec mS cm^{-1} 0.36 was reported by Landon (1991) to be suitable since the generally recommended irrigation water for bananas should have less than 1 Ec mS cm^{-1}.

Bunch covers

Bunch covers are not currently used in Eritrea but the use of polyethylene and polypropylene or other polycarbonates are permitted for bunch covering. The materials should be removed after use and not burned on the farmland (IFOAM 2006). Thrips and other insects infesting the developing fruit are not a problem in Eritrea therefore there would be no need for bunch covers to be coated with insecticide, which would not be permitted in organic production.

Propping and guying

In the production zones no support is given to the banana plants. No estimate of the frequency of topple was made in the survey but plants falling over occurs only rarely even on Grand Naine or Williams. This is important in reducing labour cost and yield losses due to toppling.

Pest, disease and weed control

Organic farming systems require the use of biological and cultural means to prevent unacceptable losses from pests, diseases and weeds. Thus many chemical pesticides and herbicides are not allowed and all precautions should be taken to protect them from contamination of non-approved chemicals that are used in the farm and buffer zones particularly to avoid drift from sprayed crops (IFOAM 2006). Eritrean banana farmers control weeds by hand cultivation and use no herbicides.

Nematodes

Nematodes were present in all the farms surveyed (**Table 1**) but the population density was far below the economic threshold level requiring control which was given as greater than 2000 100 g^{-1} of roots by Gowen and Queneherve (1990). The most prevalent species was *Radopholus similis* but *Pratylenchus* spp. was also found. The nematode population between the fields varied between 20 and 372 100 g^{-1} of fresh root weight, and 4 and 58 100ml $^{-1}$ of soil. Such variation between the fields was probably due to the age of the banana plantation and the management of the fields in terms of soil, water and crop sanitation. These results are similar to those reported by Melakebrehan (1997) who found *R. similis* and *Meloidogyne incognita* in bananas in the Agordet area with populations ranging 2-202 100 g^{-1} fresh weight of roots and 10-30 100 ml^{-1} of soil. No difference in cultivar susceptibility between the Dwarf Cavendish and Williams and/or Grand Naine was observed. The result is therefore encouraging for producing bananas organically without nematode control. However, it is important to ensure that planting material is free from nematodes when planting new areas or propagation is by tissue cultured plants; the Ministry of Agriculture have suitable faci-

Table 1 Nematode population per 100 g of fresh weight of banana roots and per 100 ml of soil adjacent to banana mats in the surveyed farms.

Sub zone	Number of farms surveyed	Variety	Mean number of nematodes in 100 g of banana roots	Mean number of nematodes in 100 ml of soil
Agordet	7	Dwarf Cavendish	94	26
	5	Williams/Grand Naine	174	27
Tessenai	2	Dwarf Cavendish	215	44
	1	Williams/Grand Naine	64	2
Haicota	1	Dwarf Cavendish	344	58
	1	Williams/Grand Naine	16	2

lities for tissue culture.

The control of nematodes by flooding has been advocated in certain locations (Gowen and Quénéhervé 1990). When flooded all the soil pore spaces are filled thus reducing the oxygen supply and many plant parasitic nematodes are intolerant of oxygen starvation and soon die. As the bananas in Eritrea are grown using furrow irrigation, allowing the water to remain for 2 days, this could be a possible reason for the low number of nematodes. Sundararaju (2002) showed that low soil moisture coupled with high summer temperature was unfavourable for *R. similis* and *P. coffeae* therefore as the banana growing areas in Eritrea have such climatic condition (mid day temperatures are usually over 40°C) this factor might have affected the population of nematodes. All farmers that were included in the survey did not consider nematodes as a production constraint. Nematodes were reported to be successfully controlled in banana planting material by hot water treatment at 52-55°C for 15-20 min (Brooks 2004) and this could be used in organic production.

Weevils

Williams, Grand Naine and Dwarf Cavendish are all susceptible to weevils (Govender and Viljoen 2002), but none were found in the study sites. All the 42 banana farmers who were interviewed reported that they have never seen the weevil nor experienced any damage due to this pest.

Banana bunchy top virus

Plants showing symptoms of BBTV was low (**Table 2**) with only 10 plants showing symptoms of the 255 assessed (3.9%). However, for confirmation of the virus, serological tests are recommended. BBTV was present in all three varieties and there are no known resistant varieties (Brooks 1999). BBTV is disseminated by the plant parts used in vegetative propagation and the banana aphid (*Pentalonia nigronervosa*) is a vector. Aphids have been recorded on bananas in Eritrea but the species were not identified (Adugna Haile 2008 pers. comm.). Brooks (1999) suggested that a BBTV infection level of less than 5% is considered low and Thind (2001) reported that the BBTV levels were 20-32% in some parts of India. The results in this survey may have underestimated actual levels of BBTV since farmers tend to cut down and remove the affected plants as soon as they see the symptoms. BBTV is considered a serious disease in Eritrea and difficult to control, but present methods of destroying mats as soon as symptoms are observed seems adequate and concurs with other recommendations (Pillay *et al*. 2005). Additionally selecting propagation material from plants free from BBTV symptoms should continue to be practiced.

Table 2 Result of farms surveyed for bunchy top virus in the three major banana producing sub-zones.

Sub zone	Number of farms	Number of mats counted	% of mats with BBTV
Agordet	12	180	4.4
Tessenai	3	45	2.2
Haicota	2	30	3.3

Cigar end rot

Cigar end rot was found on nine of the 17 farms surveyed with six in Agordet, two in Tessenai and one in Haicota, but the mean incidence of the disease only 3.7% (**Table 3**). The low incidence could be due to the very low relative humidity in these areas since high humidity has been correlated with high levels of the disease (Pasberg-Gauhl and Gauhl 1994). At the levels found in the survey there is no justification for any control.

Table 3 Result of farms surveyed for the presence of cigar end rot disease.

Sub zone	Number of farms surveyed	Total number of mats counted	% mats with cigar end rot
Agordet	12	180	3.3
Tessenai	3	45	4.4
Haicota	2	30	3.3

Intercropping

During the first 4-6 months after planting intercropping bananas with vegetables including tomatoes, onions, pumpkin and pepper is common so that the soil and water are utilized more fully and also weeds could be can be efficiently managed. This practice of intercropping is consistent with IFOAM (2006) that encourage biodiversity and efficient utilization of resources.

Postharvest

Postharvest handling in Eritrea includes few treatments to control damage and none to control disease on the fruit. From the survey no farmer used deflowering, bunch bagging, washing, delatexing, grading and packaging; nor did they apply any chemicals postharvest. Bunches were cut from the plant and transported by carrying them on a worker's shoulder to the shade. They are then loaded as bunches onto lorries for transport to the ripening rooms, which are mainly in Asmara. The product quality was low with considerable levels of external bruising and none would be suitable for export. In interviews with people involved in the marketing chain there was concern that improvements in fruit quality will not result in increased prices on the local market (Biniam 2004). One ripener claimed that the bruises on the skin were superficial and did not affect the edible part of the fruit, which is not true.

Crown rot

A major postharvest challenge in organic production is crown rot. Fungi infect the surface where the hands have been cut from the stem and develop during distribution and ripening. Various fungi that are involved have been identified in many countries, but *Colletotrichum musae* is the most common and *Botryodiplodia theobromae Cephalosporium* sp. *Ceratocystis paradoxa*, *Colletotrichum gloeosporiodes*, *Deightoniella torulosa*, *Fusaruim oxysporum F. pallidoroseum*, *F. roseum*, *F. semitectium*, *F. verticillioides*, *Latiodiplodia theobromae*, *Phomopsis* sp., *Thielaviopsis paradoxa*, and *Verticillium theobromae* have also been observed (Thompson and Burden 1995).

Crown rot is common on bananas in Eritrea and no precautions are used to control it, but for export control measures are essential. Banana exporting countries use postharvest chemical control. The most common is the benzimidazole group of fungicides, usually thiabendazole (2-thiazol-4-yl benzimidazole) which has been used by the banana industry for over 50 years. Resistance of certain crown rot fungi to benzimidazole fungicides have occurred and imazalil (1-[allyloxy-2,4-dichlorophenethyl] imidazole) is often used in sequence with thiabendazole to prevent the build up of resistant fungi. However these chemicals are not permitted in organic production and other methods have been evaluated.

In vitro studies by Al-Zaemey *et al.* (1993) showed that potassium sorbate and sodium benzoate prevented growth of *C. musae*. When potassium sorbate or sodium benzoate in combination with Semperfresh Acid-Stable was placed on wounded areas of bananas that had been inoculated with *C. musae* it delayed the lesion expansion for up to 7 days. Alvinda *et al.* (2006) dipped fruit for 10-15 min in different salts and after 17 days storage those that had been dipped in sodium oxychloride had a reduction of 67% and those that had been dipped in sodium bicarbonate had a reduction by 62% in crown rot compared to those that had not been treated. United Nations (2003) recommended moistening the cut part with vinegar. Cinnamon and clove essential oils were shown to reduce crown rot (Ranasinghe *et al.* 2002). Lassois *et al.* (2008) found that treating the cut crowns with the yeast *Candida oleophila* gave 54.4% protection against crown rot fungi. Crown rot control with bacterial antagonists has been studied but they appear to be insufficiently effective on their own. De Costa and Erabadupitiya (2008) recommended hot water treatment at 50°C for 3 min combined with the *Burkholderia cepacia* complex. The most effective treatment found by Williamson *et al.* (2008) was *Pseudomonas syringae* strain ESC11 combined with 250 g l^{-1} each of thiabendazole and imazalil, but this would not conform to organic standards.

Delatexing

Latex flows from the cut surface of the banana hand can result in staining of the fingers that can reduce their market quality. Alum (potassium aluminium sulphate) is a commonly used delatexing agent, but it is not acceptable for organic production. Extracts from lemons or orange seeds can be used which conform to organic requirements (United Nations 2003). Another alternative is placing the cut hands directly into flowing water from a stream, but no such facilities are available in Eritrea.

Packaging

The IFOAM standards require that packaging materials and containers contain no synthetic fungicide, preservative, or fumigant (IFOAM 2006). Eritrean banana farmers conform to this requirement.

Implementation

Implementation of organic production could be through farmers' associations. There are two farmers associations in Eritrea whose objectives are to:

1. control and stabilize the market price of horticultural produce,
2. represent farmers in various governmental and non-governmental meetings
3. establishing agricultural input marketing centres so that farmers can get inputs easily and cheaply.

These associations of farmers present a significant channel that can be utilized in the conversion and certification of organic bananas. It facilitates the easy dissemination of extension information and disbursement of benefits, support services and group certification.

The feasibility of organic banana production

Currently the main banana production and marketing constraints were ranked by the farmers as follows:

1. Lack of capital
2. Lack of farm equipment
3. High labour costs
4. High cost of diesel and spare parts
5. Lack of market and of market information
6. Price fluctuation
7. Lack of agricultural knowledge
8. Transport facilities
9. Low soil fertility
10. Weed control

The various environmental factors, soil types, absence of diseases and pests, the short distance to European and Middle East countries are conducive for the production and export of organic bananas. This seems adequate for competitive production against the main organic banana producing countries of Latin America and the Caribbean.

The cost:benefit ratio of the banana growers is encouraging, since the production per kg of banana in the first year of establishment is 2.34 Nakfa, with a wholesale price of 3.5-5.0 Nakfa in Asmara with reducing costs in subsequent years. From the total costs, the labour costs are the highest (48%) (Ogbalidet Drar 2006). According to a study in 2000, banana workers' average monthly wage in Ecuador was US$56 in Colombia US$200-300 and US$150-200 in Honduras (FAO 2003). While in Eritrea it is US$80-100 (1200-1500 Nakfa) per month. Production costs of bananas per hectare per year in 2005 were calculated as Nakfa 105, 336. Hence the availability of cheap labour will be a comparative advantage for Eritrean farmers to compete with other producers.

Eritrea is closer geographically to Europe than some of the major banana exporting countries, thus this could be an advantage for developing the organic production of bananas e.g. it takes 21-27 days from Costa Rica to Europe (Zapata *et al*. 2000). In the European Union in 2002, the consumption of organic bananas was estimated at 88,000 tonnes $year^{-1}$, and organic bananas represented over 1% of the North American market (FAO 2003a). If Eritrean exporters can target the Italian organic market it will be more economic since there is long standing historical relationship and bananas were being exported to Italy in 1970's by Italian investors. Italy follows the basic EC Regulations on organic food products (EC Regulation No. 2091/91). The need for specific organic import certificates and long bureaucratic procedures are the main constraints for exporting to Italy (FAO 2001).

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