Smallholders and pesticide issues in fresh fruit and vegetable supply chains, with a focus on Senegal.

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Food & Fairness Case Study

PESTICIDE ACTION NETWORK UK

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Contents

Executive Summary

This case study reports findings from survey, workshop and focus group activities with smallholder horticulture growers in Senegal as part of the Food & Fairness project conducted by PAN UK and PAN Africa during May 2005-Jan.2008. It starts by pulling together some recent findings from desk research on African small-scale farmers (SSF) involved in export horticulture, examining the importance of horticulture for livelihoods and noting some key issues in relation to export market requirements and SSF participation in export supply chains. Rather than covering these issues in general, which have been discussed in the growing academic and donor project literatures, this study takes a closer look at pesticide and pest management issues, including the impacts of EU pesticide regulations and private voluntary market requirements, especially GlobalGAP.

Section 2 summarises lessons learned at the European/African stakeholder workshop organised by the F&F project in Oct. 2007 in relation to successes and challenges in improving SSF compliance with pesticide handling requirements in export chains. These include: experiences with using technical staff for pesticide application, as opposed to SSF handling and decision-making; storage issues for hazardous pesticides by SSF and farmer groups; and challenges in achieving full compliance with use of personal protective equipment under tropical conditions. Issues around the value and costs and benefits of introducing lists of prohibited or restricted pesticide compounds are discussed, along with assessment of the progress of GlobalGAP and other supply chain initiatives to implement Integrated Pest Management strategies in African production, particularly with SSF.

Detailed information and analysis from the F&F case study research conducted by PAN Africa in Senegal is described in section 3. Export vegetable production in Senegal has risen rapidly, more than doubling volumes between 1995 and 2004. Senegal enjoys a good market in the European off-season during November to April, notably for green bean, its major vegetable export crop, and cherry tomato. Other export crops are mango, melon, okra and chilli pepper. Cherry tomato exports are growing most rapidly and Senegal is now the second largest non-European supplier during the winter months. Export crops, however, remain a minor part of total horticulture production, with only 5% of national fruit and vegetable production exported. High volume crops for local markets are onions, sweet potato, tomato, cabbage and melon. Tomato is grown for fresh consumption and for processing for tomato paste, an important component of the national diet.

A decade ago, 80% of Senegal's horticulture produce originated from small and medium producers. Since then their role has been declining, as large-scale commercial producers have entered the market for export in particular. Some of these companies run integrated operations, growing, packing and shipping their own produce, while others work with outgrowers or buy from independent SSF. Export production is concentrating in fewer and fewer hands: by 2005 just 5 producers accounted for 80% exports, of which one company accounted for 30%. F&F research found that exporters are no longer prepared to sub-contract growers or buy SSF produce unless they can ensure quality and food safety compliance via training and close supervision. Nevertheless, SSF still provide some export vegetables, with export companies recruiting field managers, to make sure field protocols are followed.

Research by PAN Africa in 2001 revealed a wide range of pesticides in use by SSF in horticulture, and highly hazardous practices in handling and storing these. A 2004 survey by the Senegalese Agricultural Research Institute highlighted a wide range of pesticides in use, 39% of which were organophosphates, plus use of unknown mixtures and poor mixing and dosing practice. F&F field survey by questionnaire in 2005 found that over 80% SSF prioritised chemical control methods, with only 16% using alternatives. Only 34% sourced pesticides from authorised distributors, the majority bought from informal and unlicensed local outlets. This practice poses definite health hazards for the dealers themselves, growers and consumers since products circulating in informal channels may be unlabelled, adulterated or unauthorised for vegetables.

Methamidophos, an acutely toxic WHO Class 1b compound, was the most frequently used active ingredient, followed by cypermethrin and methomyl. 90% of SSF respondents did not use gloves, nosemask, eyeshields, boots or even long trousers, while 83% threw empty containers away, re-sold (8%) or re-used them (5%), all risky practices. The majority (92%) were aware of toxic effects, but only 7% reported personal experience of poisoning episodes. Almost all knew that pesticide residues could remain in produce yet their respect of pre-harvest intervals (PHI) varied from 3-21 days. Only 16% had received training in either IPM or organic methods, while four others had followed other training on pesticide use. Despite pesticide education activities, only 23% said they had changed their pesticide practice (mainly reducing volume applied and respecting PHI), revealing major problems in training effectiveness and follow-up. IPM trained farmers had achieved some successes and reduced their pesticide use and production costs via decreasing the quantity of seed, number of pesticide applications and volume of mineral fertilisers, improved decision-making and adopting physical and botanical methods. Farmers highlighted that IPM requires considerable time in the field and more labour and found it difficult to work out pest thresholds, application timing and how to choose the best natural or chemical pesticide. Control of nematodes remains a real problem, along with whitefly.

Trained and untrained SSF interviewed in focus groups were aware of the acute risks that pesticides can pose to health. Symptoms of headache, nausea, generalised fatigue and skin problems were associated by farmers with poor handling of pesticides. Some untrained SSF continued to suffer chronic ill health problems as a result, while IPM-trained farmers paid more attention to avoid the risks of exposure they used to run before. Anecdotal accounts of ten actual or suspected poisoning incidents are detailed from farmers in 3 villages.

Market channels used by SSF are described. Differences between production practices (organic, integrated production, quality production, conventional) are not distinguished in the Senegalese market and SSF felt that local consumers were only interested in price and physical appearance and unaware of intrinsic quality. Horticulture marketing is poorly organised and significant wastage happens at individual farm and national levels. Results are summarised from the F&F survey of consumers and fruit and vegetable vendors in urban markets on their purchasing criteria, quality perceptions and knowledge of pesticide and residue issues. Trust in the vendor was the most important factor for consumers, followed by food safety and shopping convenience. Over 50% of consumers were aware that pesticides can remain as residues in fruit and vegetables. 43% had heard of organic produce, while 38% would not be prepared to pay more to buy organic produce. Physical appearance and trust in supplier were the main factors influencing vendors' purchasing decisions, followed by freshness, supply and taste. 22% of vendors were totally uninformed about the hazards pesticides can pose in agriculture. Issues of market reward for organic and IPM SSF production are discussed.

Section 4.explores food safety and pesticide health risks with a focus on tomato. A small number of tomato and cabbage samples from Senegalese produce in local markets grown under conventional, IPM and organic systems were analysed for pesticide residues by the F&F project. Results showed zero residues in all the organic and IPM produce, while 23.5% of conventional produce was contaminated, with EU MRL and toddler safety levels exceeded in two samples and two samples containing multiple residues. Results are discussed in relation to farm level hazard and consumer food safety in different systems and supply chains of tomato production in Europe and Africa.

Elements and key actions for a strategy to foster quality demand by Senegalese consumers and vendors are outlined from stakeholder workshops held in 2005 and 2008. These include awareness-raising and education; residue testing; training, research and policy support for IPM and organic farmers; alternative marketing channels; and development of a 'Rainbow' label for IPM/organic produce. Case study conclusions consider how best to develop demand in African countries for safer pest management practice and pesticide-free produce and on progress, obstacles and opportunities for IPM in African export horticulture.

1. Importance of horticulture and African livelihoods.

Developing countries dominate global production of fresh fruit and vegetables, growing three-quarters of all supply, and increasingly trading much of this in international markets (SOMO, 2005). Nevertheless, the majority of horticulture production is still grown for local, domestic markets and much of this by small-scale farmers (SSF). The horticulture sector thus represents an important livelihood for several million farmers, farm workers and their families in African countries.

There has been rapid growth in non-traditional export crops, particularly fresh fruit and vegetables, since the late 1980s. By the late 1990s, an estimated 45 million people in African, Caribbean and Pacific countries depended on horticultural exports to the EU for their livelihoods and approximately 7 million people were employed in the sector, many of them women (Chan and King, 2000). Over 1 million livelihoods of rural poor in Africa are supported by export horticulture to the UK alone (NRI, 2006).The export horticulture sector can provide direct benefits for development and poverty reduction goals by providing jobs and improving income for SSF and workers (Sonka et al., 2005; (Maertens & Swinnen, 2006; Minten et al., 2007; www.agrifoodstandards.net). However, other studies highlight problems in gender equity, worker rights and working conditions in field production and packing operations (Barrientos et al., 2003: Dolan, 2004; Mannon, 2005; WWW, 2007).

2. Export market demands and smallholder participation.

The recent transformation of agribusiness and food retailing structure and governance has profoundly affected supply chains (Reardon and Barrett, 2000; Busch and Bain, 2004; Dolan and Humphrey, 2004). The implications of changes in private standards, individual company and market sector requirements on developing countries' export agriculture is a major topic of interest (Dolan and Humphrey, 2000; Barrientos *et al*. 2003; Garcia Martinez and Poole, 2004). Retail structural change is characterised by four key elements: the shift to centralised purchasing; the emergence of specialised wholesalers and logistics firms; the use of preferred suppliers; and the development of private standards on food quality and safety (Vorley et al, 2007). These trends, but particularly the impact of private or voluntary (i.e. non-regulatory) standards, have raised concerns for the viability of SSF participation in high value supply chains (Vellema and Boselie, 2003; Vorley et al., 2007; Maertens and Swinnen, 2006).

There are specific issues for agro-exporters' compliance with requirements on quality, traceability and food safety, which may be difficult for them to achieve when sourcing from smallholders (Dolan *et al*. (1999). These include: the need to control variation in agronomic practice, including pest management, for a large number of farmers; ensuring farmer compliance with health and safety regulation and confidence in correct pesticide use; communication of changes in procedures to large number of farmers; logistical aspects of implementing produce traceability and accurate record-keeping when dealing with large numbers of SSF, many with low educational level. Bilateral donors (notably US, Germany, Netherlands, UK) and some private companies have funded several capacity-building programmes to help African SSF and the export companies that source from them to comply with EU legal requirements on food imports (see Graffham 2006) and with private food safety standards, notably EurepGAP (renamed GlobalGAP since Sept. 2007). The EU-funded Pesticide Initiative Programme of COLEACP is entirely aimed at supporting the ACP countries' horticulture export sectors to comply with EU market requirements and this has included specific training and investment for SSF compliance, with over 90,000 farmers receiving training by 2007 (PIP, 2007).

Concerns about SSF exclusion from EU export horticulture markets as standards become stricter and more complex have been widespread, including in the PAN UK Food & Fairness case study country of Senegal and which was one of the factors prompting this project. However, quantitative data on how many SFF are affected has been largely missing. To remedy this, the Agrifood Standards research programme by International Institute for Environment and Development and the Natural Resources Institute studied impacts of food standards in relation to African smallholder involvement in export supply chains to the UK during 2005-07. The UK retail market is seen as one of the toughest for African exporters to enter in terms of quality and pesticide controls. The research conducted estimates that over 50 per cent fewer SSF in five countries studied in East and southern Africa accessed high-value chains supplying UK retailers between March 2005-September 2006 (NRI 2006). Most of the decline has occurred in Kenya, the country with the largest numbers of SSF in export chains. Prior to 2003, the majority of export companies relied on casual purchases of vegetables from large numbers of SSF via a system of brokers. Following the introduction of EurepGAP in September 2003, companies started efforts to gain compliance certification for an estimated 9,342 smallholders among 11 companies. As of mid 2006, 60% of these smallholders had been dropped by the export company they were linked with in 2005 or withdrawn from EurepGAP compliance schemes as a direct result of non-compliance with EurepGAP.

The case studies by Agrifood Standards highlight that while there are many components to SSF dropping out of EurepGAP certified supply chains, the primary reason is financial rather than technical ability to meet the standard. The decline in SSF participation reflects the increased costs and managerial burden associated with meeting private sector standards. In Kenya, the costs of establishing EurepGAP compliant farmer groupings averaged over £1,000 per SSF and annual maintenance in the scheme over £750, whilst income from export sales averaged £200. Export companies or donors have therefore had to pay for the major proportion of these costs but this is not sustainable, particularly for smaller companies or where donors fund only some of the initial set-up investment. The studies also show that SSF leaving EurepGAP chains continued producing vegetables or fruit, selling to local markets and many continued to sell to exporters selling to less stringent markets. A small number were absorbed into groups managed by other export companies and are still trying to achieve EurepGAP compliance (Graffham et al. 2006). Interview research from another study on SSF involvement in green bean production in Kenya, Zambia and Ethiopia also confirms that food standards have acted to filter out SFF from the strictest export markets, although some have been able to remain in export production, either through substantial investment from government or public-private partnerships, through supplying the less rigorously monitored market for canned produce, or supplying non-EU markets (IFPRI, 2007).

2.1 Benefits of EurepGAP compliance

In the Agrifood Standards research Zambian SSF reported the benefits of EurepGAP compliance as increasing their farm efficiency and yields, improving plant health and food safety of products, food safety and hygiene training, with spin-off benefits as workers apply knowledge in the home,and improved health and safety of farm workers, especially those involved in handling pesticides. Kenyan farmers who had attained EurepGAP certification were clearly reaping benefits from the adoption of good agricultural practice, record keeping and improved hygiene. Yields were generally higher and input costs reduced as the growing process was better managed. Many farmers said that they were using EurepGAP records to understand their financial viability and run their farms more commercially. Proper handling of pesticides and improved food safety and hygiene had health benefits on farm, and in addition most farmers said that they had transferred hygiene messages to the homestead with obvious positive implications for family health. These benefits were gained through knowledge acquired during training process, as well as through implementing measures themselves. However, the Agrifood Standards research emphasized that all SSF complained of the costs, having to invest most or all of their group savings in the compliance process.

Another survey in Kenya reported significant increase in sales for some SSF and also reported increased income from local market crops as a result of employing some of the EurepGAP recommendations (FreshInfo, 2007). An earlier small study among EurepGAP certified pineapple

SSF in Ghana revealed similar benefits and highlighted how certification had also engendered a sense of pride and motivation (Gogoe, 2004).

2.2 Pesticide aspects of compliance with EU market requirements

The legal obligations on fresh produce imported into the EU in relation to pesticides specify that produce must not be treated or contaminated with the 24 pesticide active ingredients or groups banned under the EU Directive 79/117 and that residues of all other pesticides which remain when produce enters the EU must comply with the EU legislation on Maximum Residue Levels. Furthermore, any pesticides applied must be registered in the country where the crop is grown and be applied in accordance with the local pesticide label instructions (Graffham, 2006). Compliance with Directive 79/117 is unlikely to cause problems as these are obsolete substances and no longer manufactured, with the exception of DDT, which is used in some African countries for malaria control, and which could pose a contamination risk. More problematic is MRL compliance, particularly with the several hundred active ingredients withdrawn from the EU market in recent years, for which the MRLs have been set at the Limit of Detection, effectively zero. African producers are not prohibited from applying these EU-withdrawn pesticides but they cannot risk any residues remaining. One option is therefore to avoid their use completely. Another is to go beyond the pre-harvest interval time stipulated on the pesticide label between the lastapplication of the pesticide and the date of harvest . Some producers have decided to increase these considerably, e.g. from 14 days to 80 days, to ensure the disappearance of any residues (Graffham et al, 2006).

Beyond these legal obligations, private standards stipulate far more demanding conditions on pesticide use and handling. EurepGAP's protocol (EurepGAP 2007) includes over 60 obligatory requirements covering pesticides, from training of spray operators, product choice, justification and handling, use of protective equipment, respecting pre-harvest intervals, storage and record-keeping, to disposal of unused product and empty containers. In terms of SSF production, ensuring compliance with EurepGAP pesticide requirements has been challenging but certainly not impossible. Many export companies' approach is to set up highly supervised technical assistance and monitoring procedures, via a network of field agents, and exert careful control over pesticide inputs, often via direct provision and sometimes via conducting pesticide application in SSF plots. Close supervision requires considerable staff resources and investment, for example, Lecofruit runs an outgrower scheme with 9,000 SSF in Madagascar growing mainly French beans. The company employs 300 extension agents working with 1,500 farmer assistants, a ratio of 1 supervisor to every 5 SSF (Minten et al., 2007).Homegrown in Kenya employs a ratio of 1:10, with technicians checking almost daily that smallholders are using protective equipment and operating knapsack sprayers correctly. Supervision by field agents covers not only pesticide use but also seed and fertiliser provision, hygiene and pathogen control, general agronomic advice, produce quality checks and record-keeping for traceability and standards compliance.

Despite the attention given to the role of pesticide controls in the tightening of export market requirements, there is very little detailed information published on specific changes in pesticide practice or pest management strategies undertaken by the export sector, in either large or small-scale production. The IFPRI green bean study reports that SSF have had to shift to using less toxic and more expensive pesticides. In contrast, the Agrifood Standards study notes that SSF have been able to save money by reducing pesticide use, by up to 40% in some cases. It should be noted that negative assumptions about SSF ability to comply with pesticide requirements may ignore the benefits of small-scale cropping, which may use intercropping, crop rotation and use of more cultural and physical control methods of pest control than larger-scale operations, thus avoiding many pesticide use problems (Dolan *et al*. (1999). Some companies are expanding their supply base in order to spread risk and to avoid excessive fungicide use and potential residue problems, by selectively sourcing from producers in different zones according to when crop disease levels are low. Some are increasing involvement of SSF in locations where disease pressure is low (Graffham et al, 2006).

The F&F stakeholder workshop in October 2007 (PAN UK, 2007) specifically requested experiences in pesticide compliance by SSF and identified the following lessons:

a) Using sub-contracted, external spray teams to apply pesticides on SSF farms is one strategy for avoiding the worst practices, making sure label instructions are followed, is used and equipment is correctly maintained. Donors have often funded this approach but experience in several countries shows that it just reinforces dependency on pesticides because it creates jobs in spraying, rather than questioning need for applicatio. It is unlikely that independent SSF can afford to pay external teams.

b) Many producers are ill informed about pesticides, local stores may sell them inappropriate products and there is a widespread informal market in poor quality and unauthorised pesticides. It is essential for exporters to make sure that SSF use only authorised products. Buying pesticides in bulk by export companies for distribution to SSF allows companies to reduce per unit costs to farmers and therefore encourage compliance with use of authorised pesticides only.

c) Constructing individual lockable pesticide stores on-farm is expensive and does not address spillage and other handling issues. The best solution is well-organised district level or community level storage of pesticides, supervised by trained staff. These stores need to operate flexibly and respond quickly when extra pest or disease control is needed.

d) The main pesticide compliance problems encountered by export companies, whether with large or small-scale production are enforcing use of full protective equipment at all times by all workers, and regulatory obstacles to using less toxic products. Since many African countries' lists of authorised products are years out of date, few of the newer and less toxic products globally available can be used legally (because of the EU market requirement for only products authorised in country of use to be used)

e) Another hurdle to EU retail market entry is the development of supermarket-specific lists of particular pesticides, use of which they prohibit or restrict among producers in their supply chains. Several UK supermarkets including the Co-op, Marks & Spencer, Sainsbury and Tesco (in its Nature's Choice labelled produce) have introduced these measures, with different lists of pesticides. More recently some German supermarkets have responded to NGO campaigns on residue reduction by insisting their suppliers produce to residue levels stricter than the EU or national maximum levels. Both types of requirement can pose difficulties for producers of any scale, unless there is specific support to enable them to adapt pest management practices.

In general, conclusions from the desk research and PAN UK interaction with export stakeholders suggests that although meeting export requirements on pesticide use, handling and residues can be difficult and may incur extra cost in some cases, it is not pesticide controls per se that result in SSF exclusion from export markets. Rather, it is the overall management investment required to ensure food safety and quality standards compliance and produce traceability, combined with the costs of implementing, documenting and monitoring compliance and achieving certification. This management capacity and commitment is insufficient in many small and medium size export companies, particularly if they want to gain or maintain EurepGAP certification and source from SSF. If sourcing from only a few dozen SSF or a small proportion of the company's export volumes, it is probably not worth the investment required. One study concluded that the small number of out-growers in Senegal is too small to justify investment in capacity-building of SSF associations to be EurepGAP compliant (Plantconsult, 2003). Downward price trends imposed by European retailers makes it more difficult for export companies to afford current levels of investment in training programmes and SSF organisation. In addition to the challenges of standards and legal compliance, juggling the logistics of supplying a highly competitive market, under 'just-in'-time' delivery modes is itself a major challenge for many African companies.

2.3 Adoption of IPM strategies in export horticulture

Adopting an Integrated Pest Management strategy, which aims to reduce dependency on synthetic pesticides and make use of biological, cultural and physical control methods, is another approach to dealing with pesticide compliance issues. Strategies for integrated pest management are seen as indispensable for the future of commercial horticulture by some studies looking at food safety standards (Boselie and Muller, 2002)). However, there is little information in how far this is taking place. Some, but certainly not all, export companies and public-private initiatives for SFF support conduct training for farmers and field agents in IPM, including Homegrown and ICIPE research institute in Kenya.

In terms of IPM promotion in private standards, PAN UK and others had been critical of the lack of ambition of EurepGAP to make a difference on implementing IPM, rather than just addressing correct handling of pesticides. Of 64 control points in the 2004 version of the EurepGAP protocol, only two mentioned IPM and in vague terms. There were no actual requirements to select the least hazardous pesticides, to opt for non-chemical methods as first choice before use of pesticides or to minimise the use of pesticides. It is good news that the latest EurepGAP protocol version 3.0 March 2007, which becomes obligatory in 2008, includes now three specific control points in which producers must show evidence of implementing at least one IPM activity each under the categories of prevention; observation and monitoring; and intervention. Prevention methods include ways of managing crops that reduce incidence and intensity of pest attack. Observation and monitoring covers activities to find out when and to what extent pests are present and use this information to plan appropriate pest management. Under intervention activities, producers are expected to consider non-chemical approaches, where possible.

There have been different views from developed and developing country voices within EurepGAP on how easy it will be for producers to comply with these new requirements. At the PAN UK workshop in Oct. 2007, some participants from companies and research expressed worries that the new IPM requirements could exclude even more SSF. Others, however, felt that these requirements could kickstart registration of more biocontrol agents in ACP countries with export horticulture and help make other non-chemical pest control products more available.

While quite a lot of information on individual IPM methods relevant for Africa exists, there is no easy to access compilation of practical material on a crop-specific basis to guide African horticulture producers, in either export or local market systems. The COLEACP PIP technical protocols for export horticulture crops do not provide non-chemical options and tend to focus on optimum timing of application and correct selection of pesticides for specific pests. Ghana GTZ material provides useful concepts and methods for IPM approaches but aimed more at technical extension staff. PAN Germany's OISAT booklets and database on non-chemical management of pests is geared at SSF producing for local markets, although it includes methods appropriate for export crops including tomato, green bean and mango. This information focuses on application of a variety of botanical extracts and physical methods, made using local resources, but it is not yet clear how applicable these might be for SSF export production. Individual companies may have useful experiences and practical information on IPM strategies but are often not willing to make these publicly available, for competitive reasons.

While there have been several thousand SSF trained in IPM in vegetable crops in different African countries over the last decade through Farmer Field School programmes, these have involved public sector agencies and NGOs rather than private companies and focussed on production for local markets. One question is whether there is a role for IPM, or even organic, trained SSF to supply export chains, where their produce is proven residue-free. The FFS programme run by Locustox in Senegal during 2002-04 (Diallo et al., 2003) tested produce from trained farmers and found that carbofuran, fenitrothion and methamidophos in samples of cabbage, tomato and green bean all complied with the European Union Maximum Residue Limits (MRLs) standards, while the MRL for carbofuran under conventional SSF farmer practice in the green bean samples exceeded EU standards. IPM practices allowed farmers to gradually replace specific pesticides (methamidophos, maneb, methomyl, cypermethrin and dimethoate) with the bioinsecticide, *Bacillus thuringiensis*, and extract of neem seeds. The number of treatments reduced significantly from four or five treatments to an average of one or two.

3. The Senegal case

Export vegetable production in Senegal has risen rapidly, from 7,000t in 1995 to 16,000t in 2004. Senegal enjoys a good market in the European off-season during November to April, notably for green bean, its major vegetable export crop and cherry tomato. Other crops exported include mango, melon, okra and chilli pepper. Cherry tomato exports are growing most rapidly, from under 1,000 tons in 2000 to over 5,000 tons in 2004 and Senegal is now the second largest non-European supplier of tomato during the winter months (Kuiseu and Sambou, 2005). Most of its produce goes to France and Belgium. By 2005, the country still enjoyed favourable market options in the European off-season despite ever increasing quality and uniformity requirements. Green bean is the major volume in export (5,000t in 2000, increasing to 6,750t in 2004) mainly shipped in bulk boxes, although consumer-ready packs of 500g have been introduced by one company.

In the national context, though, export products remain a minor part of total horticulture production. In 2002-03 just over 5% of national fruit and vegetable production of around 236,000t was exported. The crops produced in the highest volume are onions, sweet potato, tomato, cabbage and melon. Tomato is grown for fresh consumption and for processing for tomato paste, an important component of the national diet.

A decade ago, 80% of Senegal's horticulture produce originated from small and medium producers. Since then their role has been declining, as large-scale commercial producers have entered the market for export in particular. Some of these companies run integrated operations, growing, packing and shipping their own produce, while others work with outgrowers or buy from independent smallholders. One study of export companies in Senegal undertaken in 2003, two years after the introduction of EurepGAP standards among the major UK and Dutch retailers, found that major export volumes now came from larger exporter-owned production, although small and medium companies were still reliant on a significant proportion of produce from outgrowers or bought from independent SSF (PlantConsult, 2003). At that date most Senegalese export horticulture was destined to EU buyers not yet insisting on EurepGAP certification and only one, large-scale grower-exporter was EurepGAP certified. The study estimated there were just 210 small-scale outgrowers regularly supplying EU markets and considered them and the export companies they sold to as at risk from losing these markets if they did not organize quickly to become EurepGAP compliant.

Whilst horticulture exports have more than doubled since 1995, production is concentrating in fewer and fewer hands: by 2005 just 5 producers accounted for 80% exports, of which one company accounted for 30%. F&F research found that exporters are no longer prepared to sub-contract growers or buy smallholder produce unless they can ensure quality and food safety compliance via training and close supervision. Nevertheless, smallholders still provided some export vegetables, with export companies recruiting field managers, to make sure field protocols are followed.

Another study in 2005 with nine of the 20 horticulture exporting companies in the country's main horticulture zone of Les Niayes and surveying SSF confirmed a shift from smallholder contract-based farming to large-scale integrated estate production, due tightening food standards inducing structural changes in the supply chains (Maertens and Swinnen, 2006). It found that horticultural exports have positively affected poor household incomes in the zone but that local households benefit increasingly through paid labour in the sector, rather than as producers, noting that the poorest benefit relatively more from working on large-scale farms than from contract farming.

3.1 Pesticide use and pest management in Senegal

PAN Africa's research in 2001 revealed a wide range of pesticides in use by SSF in horticulture, and hazardous practices in handling and storing these (PAN UK, 2003). A 2004 survey of 450 SFF in Les Niayes by the Senegalese Agricultural Research Institute highlighted a wide range of pesticides in use, 39% of which were organophosphates, plus use of unknown mixtures and poor mixing and dosing practice (cited in PAN Africa, 2005).

The quantitative survey of 120 SSF carried out in 2005 by the F&F project (Kuiseu and Sambou, 2005) reported the following:

- More than 80% growers prioritised chemical control methods, with only 16% using alternatives.

- Only 34% sourced pesticides from authorised distribu tors. Informal sales via village shops and market pose definite health hazards for the dealers themselves, growers and consumers as there is very llittle awareness of the dangers of pesticides or of how to apply and handle them properly.

- 13 different insecticide active ingredients and formulations, three of which contained methamidophos, an acutely toxic WHO Class 1b compound. Methamidophos was the most frequently used active ingredient, followed by cypermethrin and methomyl.

- 90% reported they did not use any type of gloves, nosemask, eyeshields, boots or even long trousers. No proper disposal of empty containers- 83% threw them away, re-selling (8%) or re-using them (5%). Vast majority (92%) were aware of toxic effects, but only 7% reported personal experience of poisoning episodes.

- Almost all growers surveyed knew that pesticide residues can remain in produce. Their respect of pre-harvest intervals varied. Of 12 growers using methamidophos , three reported waiting 15-20 days before harvesting produce, five waited two weeks, one waited 10 days and one just seven days. The others could not say how long they left between application and harvest.

- Only 19 farmers (16%) had received training in either IPM or organic methods, while four others had followed other training on pesticide use. Most important elements of training for them were use of organic fertilisers and pesticide selection. Only 45% of trained SSF had adopted certain techniques. Despite these education activities, only 23% said they had changed their practice as a result, mainly reducing volume applied (95% of these) and respecting PHI (5%). This reveals major problems in training effectiveness and follow-up.

The focus group discussions revealed that whitefly and nematodes are the two most serious pest problems. Many insecticide applications are made against whitefly by untrained farmers but even so these do not form an efficient method of controlling this pest. Pesticides used to control nematodes are expensive and often hard to find. Untrained farmers use a wide range of pesticides but are not always able to get adequate control of pests or diseases.

IPM trained farmers were able to reduce production costs via decreasing the quantity of seed, number of pesticide applications and volume of mineral fertilisers, compared with conventional methods. Some were using local natural resources in including cow manure and plants with pesticidical effects. The introduction of IPM has led to several changes in practice: permanent observations of the field; abandoning the practice of seed broadcasting which was easy and quick, for sowing in rows; being able to manage larger areas well; and working out application thresholds. Some untrained farmers are also using non-chemical methods, including netting of seedlings against whitefly, the biopesticide Bt and botanical extracts.

Farmers highlighted that IPM requires considerable time in the field and more labour to prepare soil, sow by rows, do field scouting and prepare natural fertiliser and botanical extracts for pest control. Alternatives to pesticides are not well known or disseminated. It is also difficult to work out pest thresholds and decide when it's necessary to apply and how to choose the best natural or chemical pesticide to be used. Control of nematodes remains a real problem.

3.2 Pesticide hazard awareness and poisoning incidents

All the farmers in the focus groups, trained and untrained, felt they were well aware of the risks that pesticides can pose to health and gave examples of poisonings linked to the use of pesticides. Certain symptoms such as headache, nausea, generalised fatigue and skin problems were associated by farmers with poor handling of pesticides. The majority of untrained farmers said they did not use appropriate protective equipment, because of the high cost. Even those who had received some form of training in pesticide 'safe use', continued to treat their crops without any form of protection. Mixing pesticide solution is done in a haphazard way without concern for application dose, much less for effects on health and environment. Several had personally experienced health problems or knew of family members who had been victims of poisoning following misuse of pesticides. Some continued to suffer chronic ill health problems, such as persistent cough, frequent headaches and skin problems as a result. In stark contrast, IPPM training has made farmers much more aware of issues around pesticide use and pay more attention to avoid the risks of exposure they used to run before.

Farmers from the three groups described ten specific poisoning or suspected poisoning incidents:

1) One Sangalkam farmer told how one day after spraying he had not bothered to change his clothes or to wash and by the time he returned home he was taken ill with breathing problems and skin allergy. He recuperated but still suffers persistent consequences of this poisoning incident.

2) Farmers in Deni Birame Ndao Nord village recounted the case of a young woman who after applying pesticides used the empty bottle as a water container to wash herself. Half-an-hour later she was experiencing haemorrhage in the genital area and was rushed to hospital but the doctors were not able to save her life.

3) One farmer from Beer village explained how he realised the dangers that pesticides pose in 1992 when he lost all his goats after they browsed on a field of green beans just treated with deltamethrin.

4) One farmer from Nagga village had invited some of his friends to help in planting potatoes. He had two buckets in the fields, one containing pesticides and another with drinking water- one of his friends who came late confused the drinking water with the pesticide.

5) Two farmers reputed to be among the best producers in Nagga village, who used large amounts of pesticides and gained good yields, started to suffer from numerous health problems by the age of 60, to the extent that they could no longer carry out any active work. The villagers think that their poor health is due to their exposure to high levels of pesticides.

6) A farmer from Deni Birame Ndao village recounted the case of one producer who always used to spray his fields at the hottest point of the day until one day he suffered an attack and died as a result.

7) A farmer from Goram village talked about a case where a farmer had just sprayed several large fields and went home without taking off his work clothes before cuddling his two children. A few moments later, both children started to vomit but the family thought this was due to cholera. It was only at the hospital they realised that it was due to pesticide poisoning.

8) One farmer from Keur Massar village declared that he had been a victim of poisoning after distributing maneb fungicides to farmers in his association. After pulling off his gloves and washing his hands well he had bought some cakes and eaten them but suffered direct poisoning effects of vomiting and excessive sweating.

9) One woman from Pambal described how one of her farm workers almost died after poor handling of pesticides.

10) Another described the case of one of her husband's farm workers who had not secured the sprayer lid properly and the pesticide solution drenched him throughout application. After spraying, he spent the rest of the day with the wet clothing still on. Two days later he became extremely weak with very violent diarrhoea and was rushed to the local clinic who were able to save him.

All farmers were aware that there can be health problems from residues in food and that it is important to respect safety periods before harvesting. Some admitted they do not always respect the pre-harvest interval in local production if the traders oblige them to harvest produce well before this interval. This practice poses a serious risk for consumer health.

3.3 Market channels and quality requirements from the farmer perspective

Discussions with the focus groups revealed information on marketing issues. Farmers sell via five marketing channels: field level sales to traders known as *bana-bana*; via brokers organising daily sales; direct sale to retailers or consumers; spot markets visited by exporters; and direct contracts with exporters. The most common is via the *bana-bana* who often provide inputs on credit. However, there is no negotiation possible on purchase prices. In all but the direct sale channels, farmers lack negotiating power and information on price comparisons and feel exploited.

Farmers were broadly aware of the demands of European importers but since the majority of them do not work with export companies they don't need to respect these requirements. In terms of Maximum Residue Levels, they admitted they don't understand the concept very well but know that it means respecting the pre-harvest interval for all chemical products used. They expressed willingness to conform to importers' requirements in terms of safe use of pesticide and respecting good agricultural practice but to do this they need to have closer contacts with European importers or to be working closely with exporters.

In terms of client demands, the *bana bana* look for produce with no pest damage, blemishes or any sign of disease and that is fresh, ripe and attractive in cosmetic appearance (size, colour, grade). They also look for produce with a minimum of nitrogenous fertiliser because excess of this will reduce shelf-life and they may look at crop variety as certain varieties last longer than others do.

Differences between production practices (organic, integrated production, quality production, conventional) are not distinguished in the Senegalese market. Farmers felt that consumers are only interested in price and physical appearance and ignore intrinsic quality issues. They are not informed, or made aware of, dangers related to poor pesticide practices in the horticulture business so the efforts of farmers to produce and market better quality in its broadest sense is often in vain.

Marketing in the horticulture chain is very badly organised and there is no chain-wide organisation as, for example, in cotton. At the height of the horticulture season, the market is totally glutted and produce is sold at very low price. Farmers do recognise it is necessary to organise better among themselves and diversify production in terms of crops and timing.

Significant wastage happens not only at the level of individual farmers but also at national levels of marketing. As vegetables are highly perishable, farmers are regularly forced into rapid sales as soon as produce is harvested, which often means selling at derisory prices or abandoning unsold produce. Micro-storage units are needed to improve value of fresh fruit and vegetables. One export company is now collecting green beans which do not reach export quality and packing these in 500g containers for local consumption.

Those farmers involved in export chains acknowledge the need to look at the problems of poor trust and commitment on both sides in contract arrangements and work out better marketing routes and agreements that perform well and can be profitable for both parties.

While quality and pesticide issues are important in export production, at national level there are no initiatives geared towards Senegalese consumers to improve demand for higher quality produce.

3.4 Consumer and trader perceptions

The F&F project conducted a survey of 356 consumers and 90 fruit and vegetable vendors in the cities of Dakar and Thies during 2007 to gain some quantitative data on their purchasing criteria and knowledge of pesticide issues (PAN Africa, 2007). The main findings are:

a) 80% consumers buy part of their supplies from market stalls because these are close to home and they can find fresh produce every day. 50% also source from wholesale markets, making weekly or fortnightly purchases, to take advantage of wholesale price. Between 10- 25% purchase from supermarkets.

b) Trust in the vendor was the most important factor for consumers in influencing their horticulture purchasing decisions, followed by food safety and shopping convenience. Price and physical appearance were much less important.

c) In terms of judging the quality of fresh fruit or vegetables, over 50% cited appearance as their main criterion, followed by origin, then taste, and price. 18% consumers said that imported produce was better quality, with more taste and often cheaper than locally grown produce. However, less than 42% of consumers were happy with the quality of the produce they bought.

d) Asked whether they worry about the safety of food they consume, over 56% consumers did worry and wanted to know about the impacts of pesticides on their health and the environment and what could be done to manage these.

e) 61% of Dakar and 49% of Thies respondents were aware that pesticides used on fruit and vegetables can remain as residues in the produce. 74% agreed strongly that it is important to buy residue-free produce to safeguard their family's health. Some questioned whether rising incidence of diabetes, high blood pressure, cardiovascular problems and cancer were linked to pesticide use.

f) Only 28% of Dakar consumers had heard of organic produce, compared with 58% in Thies. The difference in awareness between the two cities is probably due to awareness-raising activities by certain NGOs and farmer associations in Thies to inform the public about the danger associated with pesticides. 40% of Dakar consumers and 36% of those in Thies would not be prepared to pay more to buy organic produce because it was not an important issue for them. For IPM produce, 47% of Dakar and 50% of Thies consumers had never heard of it.

g) Vendors generally source their vegetables from the wholesale markets or sometimes direct from farmers to reduce the purchase costs. Working with a sales broker is less favoured as they have to pay more for produce and therefore need to increase their retail prices to consumers. Quantities purchased vary according to seasonal availability. On average vendors buy 30-50kg every three days.

h) Vendors' views on quality of imported versus local produce varied considerably. 60% considered that Senegalese produce is good quality but expensive compared with imported vegetables and spoiled more quickly. Sourcing local produce regularly was difficult as the Senegalese production season is only 6 months per year.

i) Physical appearance and trust in supplier were the two main factors influencing vendors' purchasing decisions, followed by freshness, reliable and consistent supply and taste. Price and food safety were the least important factors. Some vendors explained that price was out of their control, and therefore they needed to focus on quality (i.e. appearance) as their main criterion.

j) Vendors ranked physical appearance as most important in judging quality, followed by origin, then taste and lastly price. However, only 35% of vendors were fully satisfied with the quality of produce purchased.

k) 22% of vendors were totally uninformed about the hazards pesticides can pose in agriculture. This was not considered important by them, only the availability of produce. Likewise with respect to national phytosanitary regulations, 46% of Dakar and 26% of Thies vendors had no idea what these meant. However, 46% in Dakar and 32% in Thies agreed that there should be some control on residues.

L) None of the Dakar vendors sold organic produce, compared with 17% in Thies. The latter complained that there was no price difference between conventional and organic produce, as organic requires more effort and labour, especially at the start of the season. However, if there was a large difference in price, consumers would prefer to buy the cheaper type of produce..

m) 16% of Thiès and 12% of Dakar vendors did express willingness to develop some form of purchase agreement with farmers growing organic or IPM but they raised the important question of supply in sufficient quantity. If adequate supply is not available, their customers will quickly go back to conventional produce.

3.5 Organic and IPM production

In 2003, Senegalese export companies were not really convinced of the need to use IPM and felt that careful control of pesticide application was sufficient to avoid MRL problems and continue supplying EU markets (Dankers, 2003). One obstacle to IPM adoption appeared to be the response of Senegalese export companies to the requirement for increased record-keeping for traceability demanded by EU importers. The export companies' response was to try and standardise as much as possible production practices and field operations to make documentation easier. This meant that they preferred to standardise pesticide application schedules, and saw IPM as more difficult to manage and document. By 2005, F&F interviews showed this attitude appeared to be changing and at least two large export producers were using, for example, netting to screen seedlings against aphid attack, rather than insecticides and actively experimenting with botanical extracts.

According to the 2003 study by Dankers, IPM trained farmers reported quick sales of IPM produce and a longer shelf life and better taste. IPM sales were generally in the conventional market and at conventional price. One of the SSF associations was developing ideas for an IPPM label. Organic sales were only in Thies city and these were small-scale and rather sporadic. Stakeholders involved in the the F&F project highlighted that there have been some attempts to set up small outlets for organic vegetables in Senegal but they have often not succeeded for several reasons: irregularity of supply; small range of crops available; and limited number of well-organised sources. However, by 2005 certain supermarkets in Dakar now sell a few imported vegetables with organic labels. One medium-scale producer has also been growing organic vegetables for some years, selling via a stall at the weekly market in Thies. His strategy is to sell at the same price as conventional produce, but rely on word of mouth and good reputation to ensure that he rarely has any unsold produce. He has developed a loyal customer base, including several farmers.

The Women's Organic & Fair Trade Network (REFABEC) in Thies was set up in 2005 to promote closer links between producers and consumers, rural and urban dwellers, to better appreciate organic and agro-ecological produce and promote its local sale. REFABEC's main activities are production of organics (fruit and vegetables, cereals, peanuts, *bissap* hisbiscus flowers for fruit drinks), processing, storage and marketing, buying produce from around 150 farmers trained in organic production. The network runs Saturday market stalls throughout the Commune of Thiès and a small organic restaurant and organize regular fairs, with plans to develop a processing unit for local produce. REFABEC is doing quite well and gaining customer loyalty but could expand further. They have not been able to gain a licence to trade in the main market in Thies, however, mainly due to obstruction by the local authorities who claim they will compete unfairly with existing vendors.

The Niayes Zone Federation of Horticulture Producers (FPMN) has 1,800 members, mainly smallholders from over 45 villages in Les Niayes, growing produce on around 6,000 hectares. Over 1,000 members grow vegetables and 400 of these have received IPM training since 2002 through the FAO/Ceres Locustox project. FPMN owns a cool store at its HQ but plans to develop wholesaling had still not materialized by 2006. Other SSF in Les Niayes trained in IPM are two women's development group *Mun Takku Liggéey* and Yakaar, with 180 members in total in the Rural Community of Diamniadio. They received training during 2001-03 from PAN Africa. Both women groups could expand production if they received logistical support for more equipment and for cool storage.

Workshop participants identified one of the major challenges for sustainable horticulture as the lack of either incentives or penalties in Senegalese markets to stimulate smallholders to change practice. Many Senegalese consumers understand little about food quality and consider quality only in terms of external appearance and cosmetic quality (grade, colour, lack of insect damage). Consumers also lack knowledge about the harmful effects of residues in food and other intrinsic quality factors so there is no real demand for safe and healthy fruit and vegetables. Senegalese consumer groups are much weaker than those in European countries and not able to alert public opinion in the same way about food quality and safety, although there are vocal consumer associations for water and electricity services. Encouraging consumers to demand safer production and to pay a fair price to reward quality will be a major challenge, but essential to promote more IPM and organic production.

Pesticide exposure or poisoning incidence through residues in food, while a major preoccupation in Northern countries, is very sparsely documented in Africa. One study in Ghana reported 70% of rice and beans sold by street-vendors was found to contain the organophosphate chlorpyrifos, often used for treatment of stored grains (Tomlins, 2000). Residue analysis of 98 samples of common foodstuffs in Benin in 1999 revealed an average 15% exceeded EU MRLs, with residues mainly of organophosphate insecticides used in cotton and of persistent organochlorines including DDT, no longer permitted for use (Affognon, 2005).

4.1 Residue testing in Senegal

Findings from research by PAN UK and PAN Africa during 2000-2002 suggested that pesticide contamination of food, especially vegetables and in stored grain or legumes, could be high as a result of inappropriate pesticide use and hazardous use of empty containers. Acute and sometimes fatal poisoning incidents were reported from food and drink contamination in all four countries (PAN UK, 2007b). PAN Africa tested 10 samples of Senegalese tomato from different markets in Dakar in 2005 for two pesticides: endosulfan and deltamethrin. Deltamethrin was not detected in any of the 10 samples (Mangan, 2005). Endosulfan, however, was found in 8 of the 10 samples, ranging from 0.024 mg/kg to 0.29 mg/kg, all below the EU MRL of 0.5mg/kg. Endosulfan is widely used in cotton production in Senegal, supplied on credit by the cotton companies. Earlier PAN research (PAN UK, 2003) showed that there is considerable diversion of cotton insecticides by smallholders onto food crops or sold on the informal market.

The F&F project decided to conduct residue testing to compare contamination levels in conventional, IPM and organic tomato and cabbage grown in Senegal in 2006. Table 1. summarises the produce type and origins of the 17 samples taken and the number of which contained residues. This showed zero residues in all the organic and IPM produce, while 23.5% of conventional produce was contaminated. Table 2. summarises the residues found in the contaminated samples, and their relation to EU MRLs and to safety levels. Although almost 75% of conventional produce was residue-free, where it was contaminated, it was badly so, particularly for the produce on sale in local markets, with exceedances of EU MRL and toddler safety levels exceeded in two samples and two samples containing multiple residues. The least contaminated of the samples containing residues was the tomato grown for export, which contained only one residue and did not exceed legal or safety levels. Details of the legal and safety level data and sources are given in Appendix 1.

Table 1. Fresh produce sampled and number containing residues

Crop	No. of samples containing residues
Tomato	
Organic grown for local market, 2 samples	0 (0%)
IPM grown for local market, 3 samples	0 (0%)
Conventional grown for local market, 5 samples	2 (40%)
Conventional grown for export market under EurepGAP certification, 1 sample	1 (100%)
Cabbage	
Conventional grown for local market, 5 samples	1 (20%)
Organic grown for local market, 1 sample	0 (0%)
228 active ingredients tested for under standard multi-screens by TNO laboratory, Netherland	

The testing revealed four exceedances of Maximum Residue Levels (MRLs) in conventional produce on the local market:

- for methamidophos in cabbage, at 90 times the EU MRL
- or acephate in tomato, at three times the EU MRL
- for triazophos in tomato, at exactly the EU MRL
- for methamidophos in tomato, at five times the EU MRL

The cabbage and tomato samples with exceedances detailed above would therefore be illegal for sale in the EU today.

Safety levels for toddlers were exceeded in two samples: The triazophos residue found in one of the conventional tomatoes is over four times the level considered ‘safe’ by the authorities for UK toddlers to consume in a single day (known as the Acute Reference Dose). It also exceeds the Acute Reference Dose for all diet and age groups considered by the UK authorities.

The methamidophos level found in one of the conventional cabbages is more than double the level considered ‘safe’ by the authorities for UK toddlers to consume in a single day and over three times the Acute Reference Dose for infants.

Senegalese toddlers are probably thinner than the average British ones, so their body weight is less, and they may also eat more tomato or cabbage in their diet than British children. If so, then their intake of the residue levels found in these samples in relation to their body weight could be considerable higher and the health risks worse.

The presence of multiple residues in two samples is also of concern, especially for compounds with similar modes of action, such as the three organophosphate residues found in one tomato sample, which are all neurotoxins. This is because there is very poor understanding of whether the health risk is increased when people are exposed to a "cocktail" of chemicals in their food. PAN UK recommends that to deal with the uncertainty in assessing risks of consuming mixtures of different pesticides, which may interact inside the body, an additional safety factor of 10 should be applied to current toxicological safety levels. (PAN UK, 2005).

Table 2. Legal and safety levels in comparison with Senegalese produce sampled

Crop	Residue level found in mg/kg foodstuff	EU or other MRL mg/kg	%Acute Reference Dose (for UK toddler consumption)
Tomato			
Contaminated sample 1 (grown for export)	propamocarb 0.05 mg/kg	Temporary UK = 0.1	1.0%
Contaminated sample 2 (grown for local market)	acephate 0.06 triazophos 0.01 methamidophos 0.05	EU =0.02 EU =0.01 EU =0.01	2.5% 414% 21%
Contaminated sample 3 (grown for local market)	azoxystrobin 0.02 buprofezin 0.02 ambda-cyhalothrin 0.02 difenoconazole 0.08	EU =2.0 Draft temporary EU =1.0 EU =0.1 Draft temporary EU =1.0	12.9%
Cabbage			
Contaminated sample 1 (grown for local market)	methamidophos 0.9 mg/kg	EU =0.01	229%

The PAN North America database provides a quick and useful identification of health hazards of specific pesticides, drawn from official hazard category lists (www.pesticideinfo.org). The warning status of PAN Bad Actor chemical is given to those that are one or more of the following: highly acutely toxic, cholinesterase inhibitor (neurotoxic), known/probable carcinogen, known groundwater pollutant or known reproductive or developmental toxicant. Because there are no authoritative lists of Endocrine Disrupting (ED) chemicals, EDs are not yet considered PAN Bad Actor chemicals. Table 3. summarises the acute and chronic human health hazards for the eight pesticides found as residues in the Senegalese produce sampled. Three of these qualify as Bad Actor status due to either high acute toxicity and/or neurotoxic effects. Three are suspected carcinogens and one a suspected endocrine disruptor. The only sample containing residues which does not raise health concerns from this table was the sample grown for export. The samples grown for local markets raise serious concerns for acute toxicity and effects on the nervous system or for longer term health effects if eaten regularly as part of the diet.

Table 3. Health hazards of pesticides found in Senegalese produce

Pesticide active ingredient	Bad Actor status?	Acute Toxicity/ WHO Class	Carcinogen	Cholinestease Inhibitor (nerve toxin)	Developmental or reproductive	Endocrine disruptor
propamocarb	No	U				
acephate	Yes	Slight/III	Possible	Yes		
triazophos	Yes	High/ Ib		Yes		
methamidophos	Yes	High/ Ib		Yes		
azoxystrobin	No	U				
buprofezin	No	U	Possible			
lambda-cyhalothrin	No	Moderate/II				Suspected
difenoconazole	No	Slight/ III	Possible			

4.2 Pesticide residue data from tomato sold in the UK

Analysis by PAN UK of the residue testing done by the UK government shows that tomatoes are among the ten most contaminated food stuffs sold in the UK.(). The testing is done on UK-grown and imported tomatoes. Of the 506 samples tested since 2000, 32% were found to contain residues. Most tomatoes sold in UK shops are from Spain, Netherlands and UK. Residues were found in 62%, 22% and 13% respectively of samples from these three European sources in 2004 and in 70%, 30% and 50% in the latest testing in 2007. This data shows that it is not just developing country production which encounters residue contamination. Only three samples of Senegalese tomato were tested during 2000-2007 so it is hard to draw conclusions from this small number. Two Senegalese samples contained residues and one did not.

In terms of legal compliance, four of the 506 tomato samples tested contained residues above the EU Maximum Residue Level. These MRL exceedances were all for the growth regulator chlormequat and were found in Italian and Spanish tomatoes. Use of chlormequat is not permitted in tomatoes anywhere in Europe. One sample of Spanish tomatoes in 2007 contained chlormequat at 14 times the MRL. The tomato data clearly shows that it is southern European countries' production that is riskiest for non-compliance with MRLs.

Multiple residues in tomatoes are commonly found. In 2007, 30% of all samples contained more than one residue. The two Senegalese samples in 2007 both contained multiple residues, one with four compounds and the other with five. Two of ten Dutch tomatoes had multiple residues (2 and 3 compounds), but none of the British samples. Ten out of 23 Spanish samples contained multiple residues (four with 2 residues; three with 3 residues; two with 4 residues; one with 5 residues).

Table 4. summarises human health hazards of the 20 pesticides found as residues in the 2007 UK monitoring data. Even though there are no residues of neurotoxic compounds and only four compounds are moderately acutely toxic (WHO Class II), nine compounds qualify as Bad Actor status due to their carcinogenicity or toxicity to developmental and reproductive processes. Seven are suspected endocrine disruptors. All 9 Bad Actor compounds were found in Spanish produce, three Bad Actors in Dutch tomatoes, and one Bad Actor in British and Senegalese produce.

Table 4. Health hazards of pesticides found in Spanish, Dutch, Senegalese and British tomatoes in 2007
(Source for residues found: UK Pesticide Residues Committee, second quarter report 2007 via http://www.pesticides.gov.uk/prc.asp?id=959)

Active ingredient/ Country samples found	Bad Actor status?	Acute Toxicity/ WHO Class	Carcinogen	Cholinesterase Inhibitor (nerve toxin)	Developmental or reproductive toxin	Endocrine disruptor
bifenthrin SP	Yes	Moderate/II	Possible		Yes	Suspected
chlormequat SP	No	Slight/III				
chlorothalonilSP; NL	Yes	High (US EPA)/U	Yes			
cyprodinil SP	No	Slight/III				
endosulfanSP; NL, SL	Yes	Moderate/II				Suspected
iprodione SP; UK	Yes	U	Yes			Suspected
procymidone SP; NL, SL	Yes	U	Yes			Suspected
dithiocarbamateeSP	Yes	u	Yes		Yes	Suspected
pyridaben SP	No	Slight/III				
pyrimethanil SP	No	u				
pyriproxyfen SP; NL	No	u				
tao-fluvalinate SP	Yes	u			Yes	Suspected
tebuconazole SP	No	Slight/III				
thiacloprid SP	yes	Moderate/II	yes			
TolylfluanidSP	yes	u	yes			
fenhexamid NL. UK	no	u				
triadimenol NL	no	Slight/III				
azoxystrobin SL	no					
bupirimate SL	no					
lambda-cyhalothrin SL	no	Moderate/II				Suspected

4.3 Health and environmental hazards at farm level

Aside from residue hazards for consumers, pesticides used in horticulture may pose more immediate and more serious concerns for the health of farmers and farm workers, for local residents and livestock in peri-urban horticulture zones and for protection of water and soil resources and conservation of biodiversity. Appendix II provides lists of pesticide active ingredients and used in three tomato production systems: Senegalese smallholders growing for local markets; West African producers (large or small-scale) growing for export; and British tomato growers. The lists also show the health and environmental hazards associated with each pesticide and its current regulatory status in the EU. Table 5. summarises the hazards data for each production system.

This information highlights the high proportion of acutely hazardous pesticides in use by Senegalese smallholders for local production. Four of the pesticides in use have been withdrawn from the EU market, three since 2007. The use of these acutely hazardous insecticides is of real concern, given the widespread lack of protective clothing and poor pesticide handling practices reported in PAN Africa's survey.

Growers for export use a smaller proportion of acutely hazardous pesticides. For three of the Class I insecticides in use, decisions were made in 2007 to withdraw these from EU market. The fourth is approved for use in the EU. Exporters to the EU are not legally obliged to stop using active ingredients withdrawn in the EU, but will need to comply with MRLs for withdrawn compounds, which are set at the Limit of Detection. It is certainly better in worker health and safety terms if growers can be persuaded and supported to phase out Class I and II compounds.

The data also reveals that over 60% of pesticides used in all three systems have chronic health hazards. North European glasshouse production is often thought of as low hazard, with widespread use of beneficial insects replacing much insecticide use, yet quite a lot of hazardous insecticides and fungicides remain in use. Data on pesticides used in Spanish tomato production could not be obtained to compare it with African production. However, the data on residues found in Spanish tomatoes indicate that a range of acute and chronic hazard pesticides are in use. Spanish production systems have been criticised for very poor attention to worker health and safety and environmental contamination (Lawrence, 2004; ISTAS, 2004). Phasing out pesticides with chronic health hazards remains a major challenge for tomato production in all four systems.

Table 5. Hazards data for pesticides used in African and European tomato production

Health or environmental hazard	Small-holder producers for local markets	African export producers	British producers
No. active ingredients in use	13	25	17
No. PANNA Bad Actor status compounds (%)	8 (62%)	14 (56%)	6 (35%)
No. WHO Class I and II acutely toxic compounds (%)	3 Class I + 5 Class II	4 Class I + 3 Class II	1 Class I + 3 Class II
% pesticides with acute health hazards	62	28	23
No. carcinogens	4 possible	5 known + 2 possible	3 known + 3 possible
No. developmental or reproductive toxins	1	5	3
No. potential groundwater contaminants	4	7	3
No. suspected endocrine disruptors	5	6	4
% pesticides with chronic health hazards	76	72	64

5. Conclusions from Senegal

Clearly, there are many serious problems in current pesticide handling and pest management among untrained smallholders producing for the Senegalese market, compounded by a lack of awareness or interest to avoid residues among local traders and consumers. Survey and focus group work revealed incidents of acute and even fatal poisonings of farmers, farm families and workers. This contrasts with the much greater awareness and practical actions to control residues and hazardous pesticide handling practice in the export horticulture sector.

The limited residue testing in this study revealed serious consumer health concerns for some conventional produce in local markets. Yet pesticides as a food safety issue are not adequately addressed in national food security or public health policy in Senegal. There is no monitoring on pesticide use or residues within the domestic market. As highlighted by commentators for other African countries (Vellema and Boselie, 2003), Senegal needs a national food safety framework, to improve the institutional and regulatory capacity and close coordination between Health and Agriculture Ministries and other relevant agencies. The emphasis is almost exclusively on exports while domestic food safety concerns are overlooked.

The experience of IPM or organic training is that human health can be protected although farmers need more support in the most effective ways to manage pests and diseases without using harmful pesticides, as well as marketing support. The consumer and vendor survey confirms that a huge amount of awareness-raising about pesticide effects on health and environment is needed, as well as information about alternative, safer produce. This study showed that smallholders trained in IPM and organic methods are able to produce residue-free food but need support and investment to deliver in larger and more consistent quantities.

In terms of export horticulture supply chains, Senegalese smallholder participation continues to be sporadic and the trend is for greater export volumes to be grown by large enterprises. In this situation, it may make more sense for smallholders to concentrate on improving their position in local markets, including national supermarkets. Stakeholder discussions identified the following elements for a strategy to foster quality demand by Senegalese consumers:

- Inform food chain actors about quality concepts and components
- Awareness-raising for all stakeholders
- Educate consumers about quality and steps in achieving it
- Strengthen technical and finance capacity of farmer and consumer groups
- Use media channels, especially radio and visual images
- Build quality content and interest in local marketplaces and gradually develop consumer awareness
- Analyse residues in horticulture produce to gain an idea of contamination levels consumers are exposed to and publish results from testing
- Produce posters and leaflets about dangers of poor pesticide use and harmful effects from residues

For supporting smallholders and promoting alternative pest management and production systems, some of the key actions needed are to:

- ✓ lobby for alternative systems to be considered in agriculture policy
- ✓ develop IPM and organics expertise at extension agent level
- ✓ establish retail outlets for alternative produce make better use of existing networks and dialogue forums to share practical experiences
- ✓ make more technical and awareness-raising material available in local languages
- ✓ foster closer collaboration between private, public and civil society organisations

Involvement of SSF in the F&F project, representing almost 2,000 farmers, identified several, specific actions needed:

- Conduct further farmer- farmer training on alternatives to pesticides
- Field test non-chemical options for nematode management
- Set up preservation and processing units for horticulture and cereal produce
- Support farmer associations to invest in drip irrigation equipment
- Develop a “Rainbow” label for IPM and organic produce sales
- Establish farmer-run weekly market stalls and kiosks for direct sales to consumers
- Explore options for direct purchase by hospitals, under the rationale that sick people need healthy, pesticide-free produce.
- Organise a national forum in Dakar via a workshop at FIARA (Senegal’s annual International Fair for Agriculture & Animal Resources) under PAN’s slogan *Feeding the World without Poison.*
- Promote 1-3 specific crops produced under IPM or organic systems, to encourage their marketing in hotels, supermarkets or others, along with an information campaign, better packaging and presentation.
- Explore export options for dried produce, including organic mango and *bissap* (hibiscus flower drink)
- Research into biodegradable and greener packaging materials for Senegal.
- Create a nutritional centre to supply organic produce for children and for old people, at district level and in the rural communities.
- Make joint efforts to lobby for concrete policy support for organic expansion in Senegal

6. Conclusions from export horticulture programmes in Africa

With increasing scrutiny on pesticide practice in export horticulture, COLEACP PIP, ICIPE and other programmes are making considerable efforts on training export companies and smallholders on correct pesticide handling practice, focussing on use of protective equipment and controls on handling and storage. With more ACP exporters becoming EUREPGAP certified, with its comprehensive list of requirements on pesticide handling, many elements of worker health and safety should be significantly improved. Organised storage, distribution and application of pesticides for SSF growers helps to reduce risks but does require considerable investment in technical field agents. However, there is no data available in the public domain to show how far these changes in export supply chains have reduced pesticide ill health or environmental contamination (more information comparing pesticide reduction aspects of different private standard schemes is provided in PAN UK's Food & Fairness case study on coffee).

There is some evidence for positive benefits for local consumers and farm families from export compliance training, where SSF are able to adapt reduced risk handling practices, pesticide rationalisation or reduction techniques learnt on export crops to local food crops and where their cash crops are also sold in national markets.

It is not clear to what extent export horticulture production is moving away from reliance on pesticide strategies for pest management. Some specific programmes have been able to reduce pesticide use, where these are linked to expertise in IPM and biological control. However, there is no widespread sharing of useful experiences in safer pest management for several reasons. Much of the effort in export company and smallholder compliance training has had to concentrate on the most immediate needs, in traceability systems and management organisation and compliance with pesticide residue and handling aspects, rather than IPM implementation. Some company schemes have succeeded in reducing use of hazardous pesticides and overall use but are unwilling to share technical details, for competitive reasons. The Real IPM company in Kenya is an important exception, with experience in biocontrol and pesticide reduction, and they are planning to make available crop-specific IPM protocols, suitable for SSF production, if funding can be found. This kind of practical advice would be extremely valuable.

EUREPGAP requirements have focussed on controlling pesticide risks and have not included requirements to select less toxic compounds or implement IPM schemes, although some minimum elements of IPM principles will be required from 2008. Unlike other crops such as coffee, cocoa or cereals, there is no international coordinating research centre or commodity board for horticulture, which means IPM experiences are rather fragmented. The establishment of the Global Horticulture Initiative in Tanzania could be a good opportunity to serve as an umbrella initiative to improve African coordination and networking on vegetable pest management and coordinate coherence between individual donor projects. Development of a Common Code for Horticulture, similar to the Common Code for Coffee, applicable to local markets, would be an important contribution for making horticulture pest management safer, more sustainable and more rewarding for SSF livelihoods. Strong signals from the European retail sector for pesticide reduction, with technical, financial support and better relations, are also essential for IPM implementation in the export sector.

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Legal levels (Maximum Residue Levels)

Crop	Residue level found	EU or other MRL mg/kg food
Tomato		
Contaminated sample 1	propamocarb 0.05 mg/kg	Temporary UK MRL = 0.1 (set 16-07-07)
Contaminated sample 2	acephate 0.06 mg/kg	Definitive EU MRL=0.02 LOD (set 22-12-05)
	triazophos 0.01 mg/kg	Definitive EU MRL=0.01 LOD (set 21-01-07, formerly 0.02)
	methamidophos 0.05 mg/kg	Definitive EU MRL=0.01 LOD (set 21-01-07, formerly 0.5)
Contaminated sample 3	azoxystrobin 0.02 mg/kg	Definitive EU MRL=2.0 (set 10-05-06)
	buprofezin 0.02 mg/kg	Draft temporary EU MRL =1.0
	lambda-cyhalothrin 0.02 mg/kg	Definitive EU MRL=0.1 (set 27-04-06)
	difenoconazole 0.08 mg/kg	Draft temporary EU MRL =1.0
Cabbage		
Contaminated sample 1	methamidophos 0.9 mg/kg	Definitive EU MRL=0.01 LOD (set 21-01-07, formerly 0.5)

NOTES: All residue legal level data obtained from UK Pesticides Safety Directorate website http://www.pesticides.gov.uk/psd_databases.asp accessed 20-12-07

LOD= Limit of Detection, the lowest concentration of a particular pesticide that can be currently detected by laboratories. For acephate, triazophos and methamidophos, the EU MRLs have recently been set at the limit of detection. In effect, any residues of these compounds found in these foodstuffs would breach EU MRL legislation.

Toxicological safety levels

PAN UK used the risk assessment model used by the UK Pesticides Residues Committee (PRC) to assess whether the levels found in the produce sampled by PAN Africa exceeded Acceptable Daily Intake (ADI) levels, for chronic exposure, and Acute Reference Dose (ARfD) levels for high, single day exposures. The calculations were done for a small child (toddler), which in the UK is given an arbitrary body weight of 14.5kg. The safety level calculations take into account how often and how much of a food item is eaten in the diet of 10 different age and cultural groups, based on UK dietary consumption surveys.

Crop	Residue level found	Acceptable Daily Intake (ADI)	%ADI (for UK toddler consumption)	Acute Reference Dose (ARfD)	%ARfD (for UK toddler consumption)
Tomato		Mg/kg body weight/day		Mg/kg bw/day	
Contaminated sample 1	propamocarb 0.05 mg/kg	0.09 (UK) 0.4 (Cx)	<1%	2.0 (Cx)	1.0%
Contaminated sample 2	acephate 0.06 mg/kg triazophos 0.01 mg/kg methamidophos 0.05 mg/kg	0.03 (Cx) 0.001 (Cx) 0.004 (Cx)	<1% 26% 3%	0.1 0.001 (Cx) 0.01 (Cx)	2.5% 414% (>100% for all dietary groups) 21%
Contaminated sample 3	azoxystrobin 0.02 mg/kg buprofezin 0.02 mg/kg lambda-cyhalothrin 0.02 mg/kg difenoconazole 0.08 mg/kg	0.1 (EU) 0.01 (Cx) 0.005 (EU) 0.01 (UK)	<1% <1% 1% 2.1%	n.a. n.a. 0.0075 (EU)	12.9%
Cabbage					
Contaminated sample 1	methamidophos 0.9 mg/kg	0.004 Cdx	38%	0.01 (Cx)	229% (381% for infants)

All residue safety level values obtained from UK Pesticides Safety Directorate (PSD) website http://www.pesticides.gov.uk/psd_databases.asp accessed 05-09-06.

Safety level calculations were done by PAN UK via the spreadsheets available via the PSD, using UK dietary consumption date for 10 different age/cultural groups.

Cx= Codex Alimentarius, the global toxicological ‘safety’ levels established by the Joint Meeting on Pesticide Residues, the group of experts convened jointly by FAO and WHO.

n.a. = not applicable (acute reference dose mainly exist for neurotoxic pesticides, mainly OPs and carbamates)

Appendix II Information on hazards of pesticides used on tomatoes in African and European production systems.

The following tables provide information on the different active ingredients used by Senegalese smallholders for local markets, in West African export tomato and by British tomato growers. It shows the WHO Class and PAN North America Bad Actor status for each pesticide, along with its EU regulatory status at end of 2007.

Active ingredients/ WHO Acute Toxicity Class	Family	Bad Actor status	EU status (decision date)
Methamidophos Class Ib PIC (products >60% concentration)	Organophosphate	Yes AT; CI; poss. GC	Temporary EU approval to June 2008
Deltamethrin II	Pyrethroid	No	Approved EU-wide
Triazophos Ib	Organophosphate	Yes CI	Withdrawn (2002)
Methomyl Ib	Carbamate	Yes AT; CI; ED; poss. GC	Withdrawn (2007)
Acetamiprid III	Neo-nicotinoid	No	Approved EU-wide
Dimethoate II	Organophosphate	Yes AT; poss.C; CI; DRT; poss. GC	Approved EU-wide
Sulphur U	Inorganic mineral, permitted in organic	No	In use, under review
Fenitrothion II	Organophosphate	Yes CI; ED	Withdrawn (2007)
Maneb U	Carbamate	Yes CI; DRT; ED	Approved EU-wide
Dicofol III	Organochlorine	Yes AT; poss.C; ED	In use, under review (some formulations severely restricted)
Cypermethrin II	Pyrethroid	No poss.C	Approved EU-wide
Esfenvalerate II	Pyrethroid	No ED	Approved EU-wide
Malathion III	Organophosphate	Yes CI; poss.C; ED; poss.GC	Withdrawn (2007)

Explanation of Bad Actor Status

High Acute Toxicity* (AT)	Carcinogen* (C)	Cholinesterase Inhibitor* (CI)	Developmental or Reproductive Toxin* (DRT)	Suspected Endocrine disruptor (ED)	Groundwater contaminant* (GC)

Bad Actor status is from PAN North America hazards database www.pesticideinfo.org using official hazard classifications for the hazards marked *. It mentions endocrine disruption status but does not yet include this as a criterion as there are no official classifications.

Prior Informed Consent (PIC) listing means the substance has been banned or severely restricted in at least two countries in different regions of the world for health or environmental reasons.

World Health Organisation Classification for acute toxicity Class 1a =extremely hazardous; Class 1b =highly hazardous; Class II =moderately hazardous; Class III =slightly hazardous/U = unlikely to cause hazard under normal use (NB not all pesticides have a WHO rating).

Permitted compounds in UK organic farming derived from Plant protection products allowed in organic farming in the UK, Soil Association fact sheet, www.soilassociation.org

Pesticides used by Senegalese smallholders on tomato, green bean and onion, mainly for local markets (from unpublished PAN Africa survey of 120 smallholders, Les Niayes zone, Oct.2005)

Active ingredients/ WHO Acute Toxicity Class	Family	Bad Actor status	EU status (decision date)
methamidophos Class Ib PIC (products >60% concentration)	Organophosphate	Yes AT; CI; poss. GC	Temporary EU approval to June 2008
Deltamethrin II	Pyrethroid	No	Approved EU-wide
triazophos Ib	Organophosphate	Yes CI	Withdrawn (2002)
methomyl Ib	Carbamate	Yes AT; CI; ED; poss. GC	Withdrawn (2007)
acetamiprid III	Neo-nicotinoid	No	Approved EU-wide
dimethoate II	Organophosphate	Yes AT; poss.C; CI; DRT; poss. GC	Approved EU-wide
sulphur U	Inorganic mineral, permitted in organic	No	In use, under review
fenitrothion II	Organophosphate	Yes CI; ED	Withdrawn (2007)
maneb U	Carbamate	Yes CI; DRT; ED	Approved EU-wide
dicofol III	Organochlorine	Yes AT; poss.C; ED	In use, under review (some formulations severely restricted)
cypermethrin II	Pyrethroid	No poss.C	Approved EU-wide
esfenvalerate II	Pyrethroid	No ED	Approved EU-wide
malathion III	Organophosphate	Yes CI; poss.C; ED; poss.GC	Withdrawn (2007)

Pesticides in use by West African farmers producing cherry tomato for export (derived from COLEACP Pesticides Initiative Programme technical protocol for cherry tomato, Nov. 2004)

Active ingredients/ WHO Acute Toxicity Class	Family	Bad Actor status	EU status (decision date)
azadirachtin	Plant-derived, not permitted in UK organic	No	In use, under review
deltamethrin II	Pyrethroid	No	Approved EU-wide
abamectin		Yes AT; DRT	In use, under review
methomyl Ib	Carbamate	Yes AT; CI; poss.ED; poss. GC	Withdrawn (2007)
bacillus thuringiensis (B.T.)	Bacterium-based biopesticide, permitted in UK organic	No	In use, under review
carbofuran Ib		Yes AT; CI; poss. GC	Withdrawn (2007)
sulphur U	Inorganic mineral, permitted in UK organic	No	In use, under review
cadusafos Ib	Organophosphate	Yes AT; CI;	Withdrawn (2007)
maneb U	Carbamate	Yes CI; DRT; ED	Approved EU-wide
dicofol III	Organochlorine	Yes AT; poss.C; ED	In use, under review (some formulations severely restricted)
cyromazine U	Insect growth regulator	Yes GC	In use, under review
fenbutatin U	Organotin	Yes AT; DRT	In use, under review
hexythiazox U	Mite growth inhibitor	No Poss.C	In use, under review
imidacloprid II	Neo-nicotinoid	No Poss.GC	In use, under review
indoxacarb	oxadiazine	No	Approved EU-wide
lambda-cyhalothrin II	pyrethroid	No ED	Approved EU-wide
oxamyl Ib	carbamate	Yes AT; CI	Approved EU-wide
spinosad U	Spinosyn Derived from fungus	No	Approved EU-wide
thiamethoxam III	Neo-nicotinoid	Yes C	Approved EU-wide
azoxystrobin U	strobilurin	No Poss.GC	Approved EU-wide
Chlorothalonil U	chloronitrile	Yes AT; CI; C; poss.GC	Approved EU-wide
difenoconazole III	triazole	No Poss.C	In use, under review
iprodione U	dicarboximide	Yes C; ED; Poss.GC	Approved EU-wide
mancozeb U	dithiocarbamate	Yes C; ED; DRT	Approved EU-wide
myclobutanil III	triazole	Yes DRT	In use, under review

Pesticides in use by British tomato growers
(from Food Standards Agency Pesticide Residue Minimisation Crop Guide for Tomatoes, March 2006

Active ingredients/ WHO Acute Toxicity Class	Family	Bad Actor status	EU status (decision date)
azoxystrobin U	strobilurin	No Poss.GC	Approved EU-wide
carbendazim U	benzimidazole	No Poss.C; ED	Temporary approval EU-wide until end 2009
copper oxychloride III	Inorganic mineral, permit-ted in UK organic	No	In use, under review
propamocarb hydrochlo-ride U	carbamate	No	Approved EU-wide
iprodione U	dicarboximide	Yes C; ED; Poss.GC	Approved EU-wide
[yrimethanil U	pyrimidine	No Poss.C; ED	Approved EU-wide
sulphur U	Inorganic mineral, permitted in UK organic	No	In use, under review
abamectin		Yes AT; DRT	In use, under review
buprofezin U	Insect growth regulator	No Poss.C	In use, under review
fenbutatin U	Organotin	Yes AT; DRT	In use, under review
fatty acid soap	Non-synthetic, permitted in UK organic	No	In use, under review
verticillium lecanii	Fungal-based biopesticide, permitted in UK organic	No	In use, under review
fenarimol U	pyrimidine	No Poss.GC; ED	Approved EU-wide
deltamethrin II	Pyrethroid	No	Approved EU-wide
nicotine Ib	Plant-derived Not permitted in UK organic	Yes C; DRT	In use, under review
pirimicarb II	carbamate	Yes CI	Approved EU-wide
thiacloprid II	Neo-nicotinoid	Yes C	Approved EU-wide