# Participation in a wood-fuel quality assurance scheme in Ireland

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**Abstract**

Wood for energy is a growing market in Ireland. However, there is some concern about the quality of the available wood-fuel. Good quality wood-fuel is essential to ensure the sustainability of a supplier's enterprise; otherwise consumer confidence may be eroded. Third-party certification schemes can contribute to distinguishing higher quality wood-fuels from lower quality equivalents available on the market. To date however, there have been no studies that have investigated barriers to the uptake of certification schemes. The objectives of this study were to investigate factors that may affect operational efficiency for the production of quality firewood and woodchip and to identify potential barriers to the uptake of energy-product certification schemes. To this end, data were gathered from questionnaire surveys of firewood and woodchip suppliers, including those with and without third-party certification to investigate aspects of their general business environment and quality management systems. The results indicated that all suppliers had adopted quality management systems in response to customer requirements. Barriers to uptake into the certification schemes were found to be attitudinal. This was based on non-certified suppliers' general perceptions that the Wood Fuel Quality Assurance certification scheme offered no incentives that would be considered sufficiently advantageous to their business to warrant such investment.

**Keywords:** *Wood, energy, quality, firewood, woodchip*.

## Introduction

Wood fuel quality is determined by combustion efficiency in the production of usable energy. Consistent production of quality wood-fuel can only be assured through the implementation of a quality management system. Quality management consists of a plan for quality control at critical control points in the wood-fuel production process. The adoption of a quality management system is an essential criterion for a wood-fuel supplier to qualify for quality assurance certification (Langheinrich and Kaltschmitt 2006). Certification schemes provide assurance to end users that they are purchasing wood-fuel to their required specifications. It also establishes trust between suppliers and end users, instils consumer confidence and facilitates efficient business management.

Guidance for quality management systems has been developed through European Solid Biofuel (CEN) standards (Alakangas et al. 2006). The full suite of standards has been adopted in Ireland, coinciding with their intermittent publishing between the

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years 2009 and 2012. The standards provide descriptions of a number of parameters for different fuel types and quality categories. Suitable methods for measurement of the parameters and how test procedures may be used to monitor fuel quality during the production process are also described. The development of quality standards facilitated the certification of wood-fuel through the Wood Fuel Quality Assurance (WFQA) scheme, an industry-led initiative administered by the Irish Bioenergy Association (IRBEA). The WFQA scheme operates under the National Working Agreement 2009, coordinated by the National Standards Authority of Ireland (NSAI). The relevant documents outline the administrative and operational measures required for suppliers to receive WFQA certification (NSAI 2010).

Since its inception in 2010, 14 suppliers have been WFQA certified (Gavigan 2014), which is about 25% of all suppliers who appear in various official directories (Teagasc 2011, IRBEA 2012, Sustainable Energy Authority of Ireland (SEAI) 2013). In reality, this proportion may be lower as there may be suppliers who do not appear in the directories listed. Against this background, the trend in uptake suggests that there may be: 1) a lack of awareness of the WFQA scheme; 2) operational barriers to the implementation of a quality management system to satisfy the requirements of the WFQA scheme; 3) attitudinal barriers based on perceptions of the WFQA scheme and 4) suppliers who are not producing commercial quantities of wood-fuel to justify participation in the WFQA scheme and official wood-fuel supplier directories. To date, there have been no studies that have attempted to investigate factors that may influence uptake of the WFQA scheme.

The goal of this study was to investigate factors that may affect operational efficiency for the production of quality wood-fuel and to identify potential barriers to participation in the uptake of the WFQA scheme. This was achieved through gathering indirect evidence from questionnaire surveys of firewood and woodchip suppliers, including those with and without WFQA in an attempt to gain a better understanding of the business environment in which they work and the quality of the management systems the suppliers have put in place.

**Questionnaire structure and sampling strategy**

Separate structured questionnaires were developed for firewood and woodchip suppliers. The questionnaires were based on a theoretical framework of quality management performance measures for suppliers proposed by Langheinrich and Kaltschmitt (2006) and a framework for the management of operational critical control points (e.g. seasoning and chipper blade sharpening) compiled by Loibneggar (2011). The areas covered in the questionnaires included: 1) source of raw material and the payment method; 2) quality management systems concerning operational critical control points in the production process, including seasoning and storage of

raw material, monitoring fuel properties in-house and machinery maintenance; 3) the information provided when selling the end product and 4) supplier's own perceptions of the WFQA scheme.

The survey of 21 suppliers (Figure 1, Table 1), with the aim of achieving a spread around Ireland, was carried out between August and December 2013. Nineteen suppliers were interviewed in person and two interviews conducted by phone. All firewood and woodchip suppliers who had WFQA certification during the last quarter of 2013 were surveyed. The remaining 10 non-certified suppliers were sourced from personal communications with members of IRBEA (Gavigan and Tottenham 2013) and from a number of wood-fuel supplier directories (Teagasc 2011, IrBEA 2012, SEAI 2013).

## Results

*Source of raw material*

Combining data from all the firewood suppliers surveyed, the total annual intake of

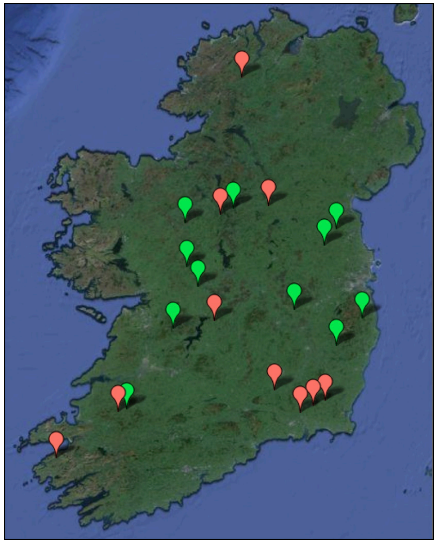

**Figure 1:** *Location of suppliers surveyed in 2013. Green markers indicate the location of suppliers with WFQA and red markers show those that had no certification.*

**Table 1:** *Suppliers surveyed by product type and certification status in 2013.*

| Certification Status | Firewood | Woodchip | Firewood and Woodchip | Total |
|---|---|---|---|---|
| WFQA | 7 | 3 | 1 | 11 |
| Non-certified | 2 | 6 | 2 | 10 |
| Total | 9 | 9 | 3 | 21 |

raw material bought was 18,426 t, whereas the total annual amount of raw material from woodchip suppliers was 54,200 t. The median annual intake of raw material for firewood suppliers was 800 t $yr^{-1}$ and ranged from 24 – 4,000 t $yr^{-1}$. The median annual intake for woodchip suppliers was 3,250 t and ranged from 500 – 15,000 t $yr^{-1}$. For all suppliers, the predominant source of raw material for processing was roundwood. In addition to roundwood, one woodchip supplier also harvested whole trees and another woodchip supplier also used sawmill residues. Table 2 lists the timber species recorded across all suppliers.

Twelve suppliers sourced their raw material from the private sector only; of which two also sourced material from their own plantations. The remaining nine suppliers sourced their raw material from both the private sector and Coillte.

Twelve suppliers replied that they had had difficulty sourcing sufficient quantities of raw material. Among the difficulties identified were: 1) competition for raw material with sawmills and harvesting contractors; 2) lack of information about tenders for roundwood sales; 3) difficulties in sourcing hardwood species; 4) restrictions in cash flow for making purchases and 5) access difficulties into private plantations during winter. Where suppliers had no issues sourcing raw material, the reasons included: 1) good market information from contacts in the harvesting and haulage business and 2) possession of raw material purchase contracts with private forestry companies and Coillte. The majority of raw material purchased from the private sector was bought on a weight basis, whereas all purchases from Coillte were on a volume basis.

*Delivery and sales methods*

Five suppliers delivered nationwide, two province-wide and one supplied on a county-wide basis. For the remaining 13 suppliers, the median delivery distance was 40 km and ranged from 30 to 81 km. All suppliers charged extra for delivering over long distances.

**Table 2:** *Species recorded in suppliers' yards.*

| **Species**[a] | **No. of suppliers** |
|---|---|
| Sitka spruce (*Picea sitchensis* (Bong.) Carr.) | 14 |
| Broadleaf species only including oak (*Quercus* spp.), ash (*Fraxinus excelsior* L.), birch (*Betula* spp.), alder (*Alnus glutinosa* (L.) Gaertn.), beech (*Fagus sylvatica* L.) and sycamore (*Acer pseudoplatanus* L.) | 1 |
| Sitka spruce and broadleaf species mixes similar to the above but also including poplar (*Populus* spp.) and maple (*Acer platanoides* L.) | 2 |
| Sitka spruce and ash | 2 |
| Sitka spruce and beech | 1 |
| Sitka spruce, Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) and larch (*Larix* spp.) | 1 |

[a] Suppliers stated that Sitka spruce was the predominant species where mixtures were recorded.

Nineteen suppliers had no formal contracts with customers as to the quantity of fuel required or frequency of deliveries. For firewood suppliers, market demand was strongest during autumn and winter. For woodchip suppliers, those who had no formal contracts made deliveries upon demand and/or when they anticipated a customer's supply was low. In all cases, woodchip suppliers had a regular customer base. Tables 3 and 4 describe the predominant sales methods for firewood and woodchip respectively.

*Quality Management systems for the control of operational critical control points*

Moisture content dictated the critical control points of the fuel production process for all suppliers. All suppliers bought their raw material freshly felled. However, four suppliers stated that they occasionally purchased seasoned material. Nineteen suppliers air dried their raw material, while two firewood suppliers kiln-dried their raw material. Of the 19 suppliers who relied on natural drying, two firewood suppliers first processed roundwood into firewood without seasoning and then contained the firewood in netting packages to facilitate drying and subsequent sales. The remaining 17 suppliers allowed roundwood to dry for a period before processing into firewood or woodchip. Across all suppliers, the median period for seasoning raw material was

**Table 3:** *The main sales methods for firewood (including the three suppliers who were producing both products identified in the survey in 2013).*

| Sales method | No. of suppliers |
|---|---|
| Bulk bags of 0.7–1.4 ($m^3$), loosely packed[a] | 4 |
| Wrapped bales (0.9–1.7 ($m^3$) capacity) | 3 |
| Net bags (45 × 65 cm dimension) | 2 |
| Customer's trailer ($m^3$), loosely packed[b] | 1 |
| Bulk bags or customer's trailer ($m^3$), loosely packed | 1 |
| Predetermined measurement of a front loader bucket ($m^3$), loosely packed[c] | 1 |

[a] Meaning firewood that has not been stacked neatly (Kofman 2006a).
[b] From predetermined measurements of a customer's trailer.
[c] The supplier uses a bucket of known volume to fill customer's trailers.

**Table 4:** *The main sales methods for woodchip (including the three suppliers who were producing both products identified in the survey in 2013).*

| Sales method | No. of suppliers |
|---|---|
| Delivered load weight and estimated moisture content | 4 |
| Delivered load weight and estimated moisture content, or by heat output[a] | 6 |
| Volume basis including moisture content[b] | 1 |
| By the delivered energy content[c] | 1 |

[a] Suppliers are paid by the kilowatt hour (kWh) output of deliveries.
[b] From a trailer of a predetermined volume.
[c] Calculated using the load weight, estimated moisture content and a reference net calorific value.

eight months and ranged from 3 to 14 months. However, inter-annual variation was significant within this range, as seasoning conditions vary from year to year and also according to the time of year the raw material was harvested. On this basis, all suppliers adjusted their seasoning periods until the target moisture content was reached before processing. This involved partitioning roundwood stacks based on the time of year the raw material was delivered. All 21 suppliers stacked roundwood off the ground, perpendicularly aligned on top of support logs. This was to prevent incombustible contaminants, such as soil and stones, from adhering to the fuel product. In addition, once material was processed into firewood or woodchip, all suppliers kept material under cover in well-ventilated areas where further seasoning took place.

In-house testing of fuel properties is obligatory to acquire and maintain WFQA certification (NSAI 2010). Twenty of the suppliers had in-house testing methods in place for moisture content determination; one firewood supplier did not formally test for moisture content, but allowed material to season and relied on experience to determine when the fuel was fit for sale. Table 5 shows the different methods used to measure moisture content.

Ten of the firewood suppliers monitored moisture content during the processing of roundwood into firewood, during packing and before sales. One firewood supplier measured moisture content after kiln drying. Ten of the 12 woodchip suppliers sampled moisture content before each delivery, one supplier sampled one-in-six deliveries and another supplier sampled a fortnight after chipping.

*Other critical control points*

In addition to moisture content, firewood quality also depends on diameter and length, the piece must be of suitable dimensions to fit into the majority of stoves and fireplaces. Eleven firewood suppliers mechanically processed roundwood to an automatic pre-set maximum firewood length; the remaining supplier used a chainsaw and a rough size guide.

In addition to moisture content the size distribution of particles is an important quality parameter for woodchip, as too many fine particles can increase fly ash and the development of clinkers within the boiler, while overlong particles can jam or cause

**Table 5:** *Methods used to determine product moisture content from the survey in 2013.*

| Method | No. of suppliers |
|---|---|
| Destructive testing with a domestic oven at ~105°C | 6 |
| Non-destructive – resistance-based moisture meter probes | 6 |
| Non-destructive – capacitance-based moisture meters | 3 |
| Destructive and non-destructive procedures[a] | 5 |

[a] In this instance all suppliers used domestic ovens and resistance probes.

blockages in feeding mechanisms. Woodchip moisture content and particle size are normative properties, which must be specified (formerly EN: 14961–4 2010; as of May 2014 ISO: 17225–4 2014).

Nine of the woodchip suppliers owned and operated drum chippers. The remaining three suppliers outsourced chipping to a contractor who operated a drum chipper. All suppliers who owned and operated their own chippers had screens installed to produce material that met the target dimensions. In addition, they were aware of the adverse effects of blade wear on chip quality and as a consequence regularly maintained the chipper blades. The decision to sharpen and/or change blades relied on visual inspections of the woodchip produced. Suppliers' maintenance periods for blades varied from daily to weekly.

*Transparency when selling the end product and perceptions of quality assurance*

Fifteen of the suppliers confirmed that their customers specified the product requirements. Firewood suppliers reported four cases wherein customers inquired about moisture content and the length of firewood, whereas three suppliers received queries from customers regarding the supply of suitable length material for use in gasification stoves. For eight woodchip suppliers, moisture content and particle size were the properties specified by customers. Twenty of the suppliers provided information to the end user, bar one firewood supplier who did not measure moisture content.

For firewood suppliers, the minimum information given was moisture content, piece length and volume for payment purposes. For woodchip suppliers, the minimum information given was load weight and moisture content on delivery. One woodchip supplier sold on a volume basis only and moisture content on delivery.

Suppliers were also asked about their own target specifications for the most critical quality parameters for firewood (moisture content and length) and woodchip (moisture content and particle size). The target parameters stated by suppliers were equated to ISO biofuel specifications (Tables 6 and 7). The purpose of the specifications was to guide in the development of market rules and reduce ambiguity between supplier and end user (Alakangas et al. 2006). In addition, these specifications can also act as guidelines for suppliers working towards the production of a uniform product. In turn, this can lead to greater business efficiency and reduces the cost of production.

*Perceptions of WFQA*

Questions on the willingness to join the WFQA scheme were posed to non-certified suppliers. Four suppliers were preparing to make an application in the near future. The remaining six suppliers were enthusiastic about the scheme, but had reservations about joining. Among the reasons cited were: 1) the application process was onerous and entailed much paperwork; 2) the scale of production was too small to justify paying the

**Table 6:** *Target ISO fuel specifications of the nine firewood (F) suppliers who were certified (C) and not certified (NC), including the three suppliers who produced firewood in addition to woodchip (F+W) from the survey in 2013.*

| Supplier | Moisture content (M, %) | Length (L, cm) | End-user category |
|---|---|---|---|
| F+W-1-NC | M25 ≤ 25 | L20 ≤ 20 and L25 ≤ 25 | Domestic |
| F+W-2-C | M30 ≤ 30 | L20 ≤ 20 | Domestic |
| F-1-NC | M20 ≤ 20 | L25 ≤ 25 | Domestic |
| F-2-C | M25 ≤ 25 | L20 ≤ 20 | Domestic |
| F+W-3-C | M25 ≤ 25 | L20-[a] | Domestic |
| F-3-C | M30 ≤ 30 | L20- | Domestic |
| F-4-C | M25 ≤ 25 | L20- | Domestic |
| F-5-C | M20 ≤ 20 | L20 ≤ 20 and L40 ≤ 40[b] | Domestic and institutional[c] |
| F-6-C | M20 ≤ 20 | L25 ≤ 25 and L40 ≤ 40 | Domestic and institutional |
| F-7-C | M20 ≤ 20 | L25 ≤ 25 | Domestic |
| F-8-NC[d] | N/A | N/A | Domestic |
| F-9-C | M25 ≤ 25 | L20 ≤ 20 | Domestic |

[a] Assigned when the target length was below 20 cm.
[b] 40 cm-lengths are used in gasification stoves.
[c] Referred to domestic-scale appliances that were used in institutions such as hotels or nursing homes.
[d] Did not measure length or moisture content.

**Table 7**: *Target ISO fuel specifications of the nine woodchip (W) suppliers, including the three F+W suppliers from the survey in 2013.*

| Supplier | Moisture content (M%) | Particle size[a] (mm) | End-user category[b] |
|---|---|---|---|
| W-1-C | M30 ≤ 30 | P31–P45 | Commercial and industrial |
| W-2-NC | M20 ≤ 20-M30 ≤ 30 | P31–P45 | Commercial and industrial |
| F+W-1-NC | M25 ≤ 25 and M50 ≤ M50 | P31–P45 | Commercial and industrial |
| W-3-NC | M20 ≤ 20 | P45 | Commercial and industrial |
| F+W-2-NC | M30 ≤ 30 | P16 | Domestic and commercial |
| F+W-3-C | M25 ≤ 25 | P16 and P45 | All scales |
| W-4-C | M15 ≤ 15-M35 ≤ 35 | P45 | Commercial and industrial |
| W-5-NC | M30 ≤ 30 | P31 | Commercial |
| W-6-NC | M30 ≤ 30-M50 ≤ M50 | P63 | Industrial |
| W-7-NC | M35 ≤ 35 | P45 | Commercial and industrial |
| W-8-C | M30 ≤ 30 and M45 ≤ 45 | P31 and P45 | Commercial and industrial |
| W-9-NC | M35 ≤ 35 | P45 | Commercial and industrial |

[a] The nominal chip size, meaning that 60% of all particles (P) fall within the size category assigned from test results.
[b] The chip size required increases with the boiler size.

annual fee for scheme membership; 3) the supplier possessed a dedicated customer-base within a local area and had no intention to expand business and 4) two suppliers felt that they were already producing a quality product as a result of past errors and feedback.

In addition, all non-certified woodchip suppliers indicated that there was no price premium for certified end-products that might help to offset the expense of WFQA certification. The WFQA scheme was perceived only as a promotional label, illustrating that suppliers were compliant with quality wood-fuel regulations.

The same questions were posed to certified suppliers on their perceptions of the WFQA, in addition to what possible measures could be taken to entice more suppliers into the scheme. All certified suppliers were satisfied with the scheme as it ensured full transparency between the supplier and end user. The perception among approved suppliers was that the scheme was effective for those who supply fuel nationwide and may not be justified for small scale suppliers. Other suggested measures included that WFQA certification be a requirement in situations where formal supply contracts were agreed with end users.

**Discussion**

The small sample size of this study and its inevitable confinement to suppliers who were already aware of the need to produce quality wood-fuels and possess quality management systems, means that results should be treated with some caution. Furthermore, suppliers are just part of market supply chains. Wood fuel quality management should also be of interest to end users, who if informed about wood-fuel quality, may be more likely to make better use of this alternative and sustainable source of energy. A previous survey (Kissane 2013) reported on issues with woodchip installations in Ireland. These issues included poor design planning of installations for woodchip delivery and ash removal, as well as a lack of after-sales service from boiler installers. SEAI approved wood-fuel stove and boiler suppliers/installers could be targeted for education and training, to address issues with planning the layout of woodchip delivery and storage facilities. Such an initiative may also appeal to end users in creating awareness towards their responsibility to store wood-fuel in a manner that maintains its quality.

Aside from suppliers and end users, there are numerous agents involved in the wood-fuel supply chain. As a result, contentious issues may arise from a lack of understanding in the interpretation of the responsibilities each of these agents has to ensure operational efficiency is maximised. Structured questionnaire surveys across all agents of the wood-fuel supply chain with the aim of gaining a better understanding of the wood-fuel market in Ireland could be conducted. Such a measure could help to inform policy makers and industry stakeholders on the efficacy of policy instruments and incentives that have been introduced to stimulate market growth in the wood energy sector and to help devise solutions to issues

that may be having a detrimental effect on market growth. The agents that should be targeted include: 1) the general public; 2) raw material suppliers who sell their products for wood-fuel; 3) wood-fuel suppliers, including those who produce other products on the market in addition to firewood and woodchip (e.g. wood briquettes and wood pellets); 4) boiler installers/fitters and 5) end users. These questionnaire surveys could form the basis of a multi-institutional research collaboration combining the knowledge and expertise of partners who have oversight on designing questionnaires, coupled with oversight into the five categories identified.

*Operational barriers*

The majority of fuel stock identified in this study was Sitka spruce (*Picea sitchensis* (Bong.) Carr.) roundwood which had been purchased on a fresh weight basis. However, Sitka spruce in its fresh state is not suitable for domestic and commercial appliances. Sitka spruce from fresh stem sections in Ireland can have a moisture content of 61% (Mockler 2013), rendering this within the M55+ category (ISO 17225–1 2014). The M55+ category has limited application for industrial end users and is not suitable for extended periods of storage.

The quality management systems for firewood and woodchip production were largely dependent on reducing moisture content. Therefore, payments for roundwood aimed at wood energy markets should be based on a standardised system that assesses moisture content. Purchasing roundwood on the basis of weight and/or volume has advantages and disadvantages for wood-fuel suppliers. Roundwood purchased on a weight basis is inexpensive and requires little professional input (Purser 2000). However, though roundwood with a high moisture content may be heavier, its energy yield will be lower. Including moisture content information would ensure roundwood was traded on a fairer basis. The moisture content of timber could be determined on delivery, with the price being paid on the basis of dry tonnes (FOROPA 2013). The methods described for measuring moisture content by FOROPA are similar to the oven-dry bark-free method described by Purser (2000). The methods described by Purser were presented as a standard procedure to determine the dry tonnages of roundwood for Irish conditions. There were no perceived operational barriers to ensuring wood-fuel could be produced to a consistent dimension. Firewood suppliers, with one exception, all employed firewood processing machinery with adjustable cutting facilities. All woodchip suppliers employed chipping machinery with screens designed to maintain a specified particle size.

*Certification schemes*

The WFQA scheme should offer incentives for certified suppliers to make it a more effective instrument for distinguishing quality wood-fuels from lower quality

equivalents available on the market. In turn, this could also encourage new applicants, as the WFQA scheme was perceived by non-certified suppliers to offer no incentives despite their efforts to produce quality wood-fuels; this has clearly discouraged further applications. A similar sentiment towards the uptake of certification schemes was found in a UK-wide questionnaire survey of firewood suppliers conducted by Kinash et al. (2013). However, the main reservation about how certification schemes were perceived by suppliers was reported to be due to a lack of knowledge of end users about quality parameters and their effect on combustion efficiency. As a result, it was perceived by suppliers that prices in general were driven down by poor quality (i.e. high-moisture content) firewood being sold on the market. In addition, some suppliers who were selling seasoned firewood found difficulties in charging a premium for their product, presumably for the same reasons relating to end user knowledge.

Increasing the impact of the WFQA scheme could first be achieved by confining market access, where end users are convinced to seek certified fuel only; this can only be effective if there is an increase in the uptake into the WFQA scheme. A potential cost-benefit analysis as part of an industry-led initiative to establish baseline prices for certified firewood and woodchip products may also contribute to increasing uptake of the WFQA scheme. However, given the heterogeneous nature of wood-fuels, a market price for certified wood-fuel products would be compromised by: 1) different wood-fuel products; 2) varying fuel specifications and requirements between and within different products depending on end user demands; 3) the methods used to sell products (e.g. volume, weight and energy content); 4) the associated business costs for individual suppliers to produce a quality wood-fuel; 5) varying transportation distances for delivering the end product and 6) an end user's willingness to pay a premium.

**Conclusion**

The data collected in this study indicated that all suppliers were aware of the importance of wood-fuel quality and had adopted quality management systems in response to customer requirements. Engaging in wood-fuel quality management was not viewed by suppliers as a barrier to operational efficiency. Barriers to increased uptake into the WFQA scheme were found to be attitudinal. This was based on non-certified suppliers' perceptions that WFQA certification offered no incentives that would be considered sufficiently advantageous to their business to warrant such investment.

An industry-led cost-benefit analysis with a view to creating price premiums for certified products could help to convince suppliers to join the scheme. However, product type, the associated business costs incurred in producing a quality wood-fuel product and the end user's willingness to pay a premium for a quality product were the key issues influencing the lack of participation in the scheme.

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