A Framework for Assessing Economic Viability of Low Rainfall Agroforestry Products

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Foreword

The search for cost effective salinity control options, as well as solutions to other agro-sustainability problems, often identifies new enterprise options that require analysis to assess commercial viability and economic potential. Further research and development is also often required to make emerging technologies viable, so a good understanding of the benefits of research and development is needed.

Australian Bureau of Agricultural and Resource Economics (ABARE) was commissioned by the Joint Venture Agroforestry Program to develop an economic framework that can be used to conduct robust assessments of the future economic prospects for low rainfall agroforestry products.

This report presents a framework for conducting market analysis, with discussion of the key factors influencing the demand and supply of products potentially made from low rainfall woody biomass feedstocks. In addition, the economic implications of research and development are explored.

This project was funded by the Joint Venture Agroforestry Program (JVAP), which is supported by three R&D Corporations – Rural Industries Research and Development Corporation (RIRDC), Land & Water Australia (L&WA), and the Forest and Wood Products Research and Development Corporation1 (FWPRDC). The R&D Corporations are funded principally by the Australian Government. The Murray-Darling Basin Commission (MDBC) also contributed to this project. The R&D Corporations are funded principally by the Australian Government. State and Australian Governments contribute funds to the MDBC.

This report is an addition to RIRDC’s diverse range of over 1800 research publications. It forms part of our Agroforestry and Farm Forestry R&D program, which aims to integrate sustainable and productive agroforestry within Australian farming systems. The JVAP, under this program, is managed by RIRDC.

Most of our publications are available for viewing, downloading or purchasing online through our website www.rirdc.gov.au.

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1, Now Forest and Wood Products Australia (FWPA)
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# Contents

Foreword ................................................................................................................................. ii

Acknowledgments.................................................................................................................. iv

Executive Summary ............................................................................................................... vii

Introduction .......................................................................................................................... 1

**Factors to be considered in market analysis** ...................................................................... 2

- Market price ......................................................................................................................... 2
- Demand side considerations ............................................................................................... 4
  - Income growth .................................................................................................................. 4
  - Substitute products .......................................................................................................... 4
  - Consumer preferences ................................................................................................. 5
- Supply side considerations ................................................................................................. 5
  - Production costs ............................................................................................................. 5
  - Productivity ..................................................................................................................... 6
  - Entry of new producers and responses of existing producers ............................................ 6
- Government regulations ..................................................................................................... 7
- Ecosystem services ............................................................................................................. 7
- The effect of research and development on competitiveness ........................................... 8
  - Gauging the benefits ....................................................................................................... 8
  - Research and development that favours all producers .................................................... 9
  - Research and development that favours only low rainfall producers ............................. 10
  - Undertaking targeted research and development ......................................................... 11

**Revisiting the preliminary assessments of the best bet products** .................................. 13

- Products from traditional forest product industries ......................................................... 13
  - F1 Appearance grade timber .......................................................................................... 13
  - F2 Dry formed fibreboard ............................................................................................. 15
  - F3 Wood-plastic composites ......................................................................................... 16
- Energy and chemical products .......................................................................................... 17
  - E1 Electricity generation from woody biomass ............................................................... 17
  - E2 Ethanol and methanol .............................................................................................. 19
  - E3 Pyrolytic bio-oil ....................................................................................................... 23

**Implications for the choice of research and development** ............................................. 24

References ............................................................................................................................. 25
Tables

Table 1  Costs of production for ethanol ................................................................. 22

Figures

Figure A  Demand and supply ................................................................................... 3
Figure B  An increase in demand ............................................................................... 4
Figure C  An increase in supply .................................................................................. 5
Figure D  Benefits from trade ..................................................................................... 9
Figure E  Industry wide R&D .................................................................................... 10
Figure F  Scope to capture benefits of R&D along the production chain ................. 12
Figure G  Wind energy cost estimates ....................................................................... 18
Figure H  Average cost of electricity generation, 2000 ........................................... 19
Figure I  Australian road transport energy use .......................................................... 20
Figure J  World average trade weighted oil price ....................................................... 21
Executive Summary

What the report is about

This report discusses some of the supply and demand factors likely to affect the future competitiveness of the six best-bet low rainfall agroforestry industries. The report then extends the preliminary market evaluations that have been undertaken by CSIRO (Hague et al. 2007).

The report also provides an in-principle analysis of the types of R&D that could increase the returns to landholders considering low rainfall agroforestry.

Who is the report targeted at?

The report will be of particular interest to policy advisers and to R&D providers.

Background

Dryland salinity poses a significant threat to agriculture and rural communities throughout Australia. The establishment of woody vegetation in low rainfall regions has been identified as a possible option for mitigating land salinisation in Australia. RIRDC funded the Best Bets for Biomass project to investigate the markets and prospects for six selected products that could be produced from low rainfall grown woody biomass.

Hague et al. (2007) identified these products as being appearance grade timber, dry formed fibreboard, wood-plastic composites, electricity from woody biomass, ethanol and the production of methanol, and pyrolytic bio-oil. This report follows on from that study and outlines a basic economic framework to assist in assessing the potential markets for these products. Implications of research and development (R&D) on the potential product markets are also included.

Aims/objectives

The aim of his project is to develop an economic framework enabling robust assessment of the future economic prospects for low rainfall agroforestry products.

Methods used

When assessing a product’s viability in the marketplace, the key consideration is the current and expected costs of production relative to the expected future price. To help form price expectations, a number of factors need to be considered:

- changes in future demand;
- changes in future supply; and
- expectations of the rate of industry productivity growth.

These questions form the basic framework for market analysis. An increase in demand driven by wealth increases, population growth or a change in consumer preferences will improve the price outlook for that product. When the growth in demand is expected to exceed growth in supply, future prices are likely to rise. Increased supply from existing producers or a new entrant will likely soften future prices. Issues such as the size of the supply increase as a result of a new market entrant or the rate of industry productivity growth will also affect the price of a product.
Results/key findings

Analysis of the six Best Bet product markets suggests that demand growth for the majority of these products is likely to be modest. On the other hand, the supply increases as a result of the entry of new low rainfall producers or increased production from existing producers are likely to be much greater.

Combined with the availability of competitively priced substitute products, these low rainfall Best Bet products are unlikely to be cost competitive; at best, many of the products will be servicing only a niche market, with little opportunity for expansion.

Often when products are considered subcommercial, attention turns to R&D as a strategy to improve product viability. However, in these cases the ability or inability of an industry to capture the benefits from R&D is clearly important. The ability to retain R&D benefits will enable a producer to reduce their costs of production and improve their market viability relative to other producers. For a low rainfall agroforestry producer, when the majority of the benefits from R&D are captured within the low rainfall sector, R&D can decrease the cost of production relative to other sectors. When benefits are shared with competitors, costs of production decrease for all producers and the advantage to the intended beneficiary of the research is eroded.

Research and development targeted at low rainfall producers, such as the development of the oil mallee crops in Western Australia, will likely have minimal spillovers to other industries and provide a way forward for low rainfall industry programs. More generic R&D (such as conversion technology for biomass to ethanol) will not necessarily assist low rainfall producers as benefits will spillover to other producers of biomass.

Implications for relevant stakeholders

The presence of technology spillovers and the fact that the low rainfall agroforestry sector will have to compete directly with many other alternative sources of biomass, particularly high rainfall forest plantations, makes identification of R&D that will facilitate the emergence of a viable low rainfall industry a complex task.

In general, R&D of processes that convert biomass into building materials or energy and chemical products are likely to favor all producers who could provide feedstock to that market. The change in per hectare returns for all producers may lead to greater total benefits for a high rainfall producer as a result of their higher biomass yields.

In contrast, there may be some potential for R&D to improve the relative cost competitiveness of low rainfall producers in areas where there are potentially fewer spillovers. Examples include genetic improvement and silvicultural management customised to low rainfall environments, as well as the development of short rotation species such as oil mallee and *acacia*.

Recommendations

Despite the present uncompetitive nature of many of the Best Bet products, other external benefits of producing agroforestry in low rainfall regions (such as salinity mitigation) may be present. If governments or resource managers do intend to consider land use options in low rainfall areas, further examination of the potential value of such externalities is required.

- The market outlook for the six best bet products is not currently favourable, largely due to the higher costs of production of low rainfall agroforestry.
- Research and development is necessary to decrease the costs of production of low rainfall agroforestry.
• R&D needs to be tightly focused on the low rainfall industry with minimal spillover benefits to other producers, in order to enhance the competitive market position of the six best bet products.

• R&D focused on aspects in the early stages of the production process is likely to give the greatest benefit to the researching industry, particularly for appearance grade timbers and electricity generation from biomass.
Introduction

Dryland salinity poses a significant threat to agriculture and rural communities throughout Australia. Lower productivity of agricultural land, degeneration of infrastructure and reductions in biodiversity are just some of the costs that it can impose. The solution to this problem is likely to be multifaceted. The establishment of woody vegetation in low rainfall regions (400–600 millimetres) is considered to be a potential part of the solution, although it is expected that broadscale adoption would occur only if driven by a commercial imperative for landholders.

As part of the research and development (R&D) effort in this field, the Joint Venture Agroforestry Program (JVAP) funded the Best Bets for Biomass project to investigate the production issues and market prospects for six selected products that could be produced from low rainfall agroforestry operations. The selected products included three traditional forest products (appearance grade timber, dry formed fibreboard and wood-plastic composites) and three energy and chemical products (electricity generation from woody biomass, ethanol/methanol and pyrolytic bio-oil). The Commonwealth Scientific and Industrial Research Organisation (CSIRO) conducted the initial stages of the project, including a preliminary analysis of the economic viability of each of the six products (Hague et al. 2007).

ABARE’s role in the project was to extend the preliminary market evaluations of the six best bet products conducted by CSIRO. This is preceded by a discussion of some of the supply and demand factors likely to affect the future competitiveness of these industries.

The initial stage of the project also highlighted the possible need for additional R&D to overcome some of the silvicultural, harvesting and processing issues specific to low rainfall agroforestry. The second issue for ABARE to address was thus an in-principle analysis of the types of R&D that could increase the returns to landholders considering low rainfall agroforestry.
Factors to be considered in market analysis

This chapter briefly examines a range of factors for consideration in a market analysis. They are relevant to any product or market analysis. Clearly, any producer entering into a market would undertake a more detailed business and market analysis than that covered here. Rather than providing a complete guide to market analysis, this chapter provides a discussion of the following key, and often overlooked, factors that determine economic viability;

- Demand and supply interactions will determine the future movements in the market price of a product. A robust market assessment must consider the factors affecting future prices.

- The effectiveness of R&D in improving the relative competitiveness of a particular subset of producers can be diminished when the benefits of the research spills over to competing producers.

- Regardless of the environmental services agroforestry may provide, the commercial viability of these land uses will not be improved without some form of government regulation or institutional arrangement that transfers some of the ecosystem service benefits to the landholder.

These issues are then considered in an extended market analysis of the six Best Bet products in the following chapter.

Market price

For any product, the key element in market analysis is the price of that product. Once producers (or potential producers) have formed an expectation about future prices, they can compare this expectation with their estimated cost of production to gauge their ability to compete in the marketplace. If the price received is greater (less) than the cost of production, they then have an estimate of the potential profits (losses) from entering the market.

In a product market, prices adjust so that the market clears. That is, the price adjusts so that the quantity that consumers wish to buy equals the amount that producers are willing to supply. Demand, or the quantity that consumers wish to buy, is inversely related to price. That is, as the price increases the quantity demanded decreases. Supply from producers has a positive relationship with price. As the price increases, producers are willing to supply more. A graph of these two elements is presented in figure A.
The levels of price and quantity traded in this market, once it has cleared, are indicated by the dotted lines marked $P$ and $Q$ in figure A. At no other price will the market clear. If the price is above $P$, there is excess supply where producers are willing to supply more than consumers wish to purchase, putting pressure on the price to drop. At price levels below $P$, excess demand for the product will push the price up. Once it settles at a level where demand and supply are equal, this is the market price and the market is said to be in equilibrium.

Factors other than product price can affect demand and supply. For example, higher income – or more specifically, higher disposable income – means that consumers have more to spend so that demand for a good may increase. An increase in demand means that for any given price, the quantity demanded will increase. This means there will be a shift up and to the right of the demand curve (figure B). At the original market price, there would be an excess demand for the good, putting pressure on the price to rise. The price rises until supply is equal to the new increased demand. This is the new, higher market price.
Figure B  An increase in demand

Other factors that influence demand and supply include consumer tastes, the cost of production, available technology, the availability of substitute and complementary products and government policy settings. Understanding how these factors influence supply and demand allows a more complete market analysis for a product. Generally, if all other factors remain the same, an increase in demand increases the market price. An increase in supply will shift its curve to the right, resulting in a decrease in the market price. Recent examples of market analysis for forestry commodities include woodchips (Nelson and Shield 2003), oriented strand board (Nelson and Kelly 1998) and a number of forest products (Love, Yainshet and Grist 1999).

Economists use various approaches to explain and measure the influences on supply and demand. Many of these approaches are quite technical, involving high levels of data and detail. For this report a simple qualitative assessment is used, known as ‘comparative statics’. Comparative statics analyses the impact of market shocks on prices, comparing the initial equilibrium with another after the shock. Market shocks are changes which cause shifts of the demand and supply curves. These shocks are investigated in more detail in the following sections. Comparative static analysis does not provide information on the path that price takes between equilibria, however, it is useful in developing a long term perspective of the impact of shocks to a market. An understanding of these issues and the market consequences will also assist in assessing the value of research and development (R&D) to improve product viability.

Demand side considerations

In addition to the price of the product in question, the main factors affecting demand at given prices are:

- income growth;
- the price of substitute products; and
- consumer preferences.

Income growth

Demand for goods tends to increase with increases in disposable income. The strength of this relationship depends on the type of good. At an economy level, strong economic growth is usually associated with increased aggregate demand. Consequently, income growth in major markets is one of the key variables that market analysts consider. For example, Nelson and Shield (2003) discuss the impact of economic growth on future woodchip demand in Japan.

Substitute products

Demand for a product is influenced by the prices of substitute products. Generally, demand for a product is positively related with a substitute’s price. That is, demand for a product will increase if the price of a substitute increases. The strength of this relationship will depend on how similar the products are. In terms of figure A, an increase in the price of a substitute product would shift the demand curve to the right.

For example, New Zealand manufactured medium density fibreboard (MDF) is almost a perfect substitute for Australian MDF. Both countries produce a high quality product from Pinus radiata and receive premium prices in the Asian market. The expected increase in New Zealand softwood supplies in the medium term could lead to increased production of New Zealand MDF and a subsequent fall in the New Zealand MDF price. Some consumers of Australian MDF are likely to switch to the lower priced substitute product thereby reducing demand for, and leading to some weakness in prices of, Australian MDF.
Product differentiation is one way of insulating the demand for a product from the competition from substitutes. If a product has distinguishing strength, appearance or production attributes, then consumers will be less likely to switch to alternatives when prices change. By differentiating their product, producers may be able to create a niche market in which higher prices can be obtained. However, niche markets are generally small (OECD 1995). There are thus limits to the ability of niche product markets to absorb additional supply.

**Consumer preferences**

Underpinning consumer demand is a set of tastes or preferences for the characteristics of a product. For agroforestry products, these characteristics can include strength in the context of product performance, the use of sustainable production methods and effects on health. Hague et al. (2007) note that consumers often prefer forest and wood products that are not sourced from native forests. Consumer tastes are most likely to change relatively slowly.

**Supply side considerations**

Important factors that influence the supply of a product and market prices include production costs, expected productivity improvements and the potential for additional or changing production from new and existing producers. Increases in supply arising from factors such as these will shift the supply curve to the right (figure C). At the original price there is now an excess supply. For producers in the market to produce less and consumers to purchase more, price is required to drop until the market again clears.

**Production costs**

The costs of production determine the quantity of a good that can be supplied at a particular price. This includes the costs of any inputs required in the production process. Generally, if production costs decrease, supply will increase. That is, for any given price, producers will be willing to supply more.

In order to obtain inputs for the production process, a producer must be able to outbid others who wish to use those same production inputs for other purposes. The bids that the different parties would offer
depends on the returns that they expect to receive from the use of that input. For a low rainfall agroforestry operation, the most crucial input is land. The production costs – and the commercial viability of such an enterprise – hinge on the per hectare returns generated in comparison with competing land uses such as traditional farming.

Estimates of commercial returns from a low rainfall plantation industry have been made by New South Wales Agriculture (Hean and Signor 2001). Hean and Signor modeled an intensively managed 1 hectare eucalypt plantation in the Liverpool Plains. Commercial thinning was carried out in year 8 for firewood and a final harvest was undertaken in year 30. Under the most favourable scenario of lowest costs and highest prices, the enterprise was only marginally viable with a net present value of $135 a hectare. This is much lower than the typical value of agricultural land in low rainfall areas of Australia, estimated in ABARE’s broadacre farm survey data to be around $300-$500 per hectare (unpublished). The key point here is that a commercially viable agroforestry operation is not characterised simply by positive economic returns, but rather returns that are superior to those expected from alternative uses of the production inputs.

Conversely, low rainfall products which are used as inputs to another production process must be cheaper in order to be competitive with other inputs.

**Productivity**

In any competitive market, steady increases in productivity tend to lead to gradual reductions in price when other factors remain unchanged. This occurs because improved productivity decreases the costs of production and, therefore, increases the amount that producers are willing to supply at any given price. These improvements can be a result of R&D, adoption of new technology or a general improvement in the use and management of inputs. Where this leads to excess supply in the market, downward pressure is placed on prices. For example, Nelson and Shield (2003) noted that the world price of woodchips, adjusted for inflation, had fallen at an average rate of 6.7 per cent a year since 1995. They projected that if current rates of productivity improvement continued, the price of hardwood chips will continue to fall at a similar rate. These productivity improvements are arising from economies of size, genetic improvement and reduced management costs of hardwood plantations. Nelson and Shield (2003) point out that the profitability of the Australian industry in the medium and longer terms will depend on continued productivity gains, favouring larger scale operations with the best management, genetic and land resources.

When a market assessment takes a long term perspective, as is needed for investments in activities such as agroforestry, then the expected productivity growth among competing producers becomes important. The only way in which to maintain profitability is to keep pace with industry productivity, as this will be placing gradual downward pressure on prices. Research and development could be one technique contributing to this and is discussed in more detail in the following section.

**Entry of new producers and responses of existing producers**

If a new producer is looking to enter a particular market, they must consider how their additional production will affect the overall supply–demand balance in the market. If the increase in production would be only a small increase in aggregate supply, then the downward pressure on price is also likely to be small. This is usually the case in a large global market with many sellers, where entry of an additional firm is likely to have no influence on the overall price. However, if a new entrant contributes a significant portion of aggregate supply, this will have tangible effects. A significant increase creates an excess supply in a market. Prices would have to fall to clear the market. It can be difficult to estimate the drop in price needed to bring a market back into equilibrium. It requires knowledge of the responsiveness of demand and supply to a change in price, which is often hard to quantify. But for now, it is sufficient to know that when a producer’s entry into the market creates significant excess supply, prices are likely to fall.

For example, consider a small Australian plant producing MDF for the world market. A viable plant would require production capacity of 150 000 cubic metres of MDF output a year (Hague et al. 2007).
If such a plant were to manufacture output solely for the North Asian market, which consumed 7.4 million cubic metres in 2002 (FAOSTAT 2002), it is likely the increase in production (which amounts to 2 per cent of North Asian consumption) would have a negligible impact on the world price of MDF. However, if MDF were not traded on the world market the 150 000 cubic metre plant would increase total Australian production by almost 20 per cent and place significant downward pressure on price.

Although the entrance of one new producer may be insignificant, the entry of new producers ensures competition within a sector. In a market with high returns and no barriers to entry, the current price level would not be expected to persist. The prospect of comparatively high prices (and therefore profits) usually encourages new producers to enter the market. As new producers enter, they contribute in aggregate to an increase in supply leading to a reduction in prices until the sector offers returns comparable to those available in other sectors.

ABARE’s analysis of the market prospects for a greatly expanded Australian jojoba industry (Morrissey et al. 1996) is a good example of the importance of understanding the impact of additional production on overall supply and the subsequent impact on price. Jojoba was being investigated in the mid 1990s as a crop that could provide commercial returns to landholders and reduce groundwater recharge in the low rainfall zone. Measured against prevailing market prices, jojoba seemed to be offering competitive returns relative to some existing agricultural activities. In addition, around 400 000 hectares of land in the Murray Darling Basin appeared suitable for jojoba production. However, plantings on this scale would increase world production by around 2500 per cent, undoubtedly having a significant impact on market prices. In order for the market to absorb this quantity of additional supply, prices would have had to fall significantly to be price competitive in new end uses. In this case, it was thought that the price of jojoba would need to fall by 80–85 per cent (or from $35–$50 a kilogram to $5–$10 a kilogram) to compete with other synthetic friction modifiers (Morrissey et al. 1996). This example highlights the caution that must be exercised when assessing prospects using prevailing prices.

Changes in supply from existing producers can also have an important impact on the market. For example, Hague et al. (2007) listed the ‘wall of wood’ in New Zealand as a major market development that is likely to influence future MDF production. For example, between 1999 and 2003 the softwood harvest in New Zealand increased by around 50 per cent, and MDF production increased by 47 per cent to over 880 million cubic metres. Since then, however, both harvest and MDF production have declined slightly. Increasing quantities of hardwood plantation feedstocks are also soon likely to be available to the south east Asian MDF industry, which will further increase supply. Other factors being equal, these developments are likely to place significant downward pressure on price into the future.

**Government regulations**

Government policies, programs and regulations can also influence the supply and demand of market products. Subsidies and taxes alter the market price for consumers or the price of inputs for suppliers. Government policies and programs may also dictate whether a producer/farmer receives payments for services provided or whether they pay the full cost of resources used. For example, in the past, owners of forest plantations were not liable for any reduction in surface water runoff caused by plantation establishment that may have detrimentally affected downstream irrigators. However, recent policy developments may mean that owners looking to establish plantations in the future, especially in high rainfall zones, may be subject to further regulation and potentially the cost of water entitlements (COAG 2004). This will add to the costs of production for these plantations and change the profitability and likely extent of future plantings.

**Ecosystem services**

From a social and long term environmental and economic perspective, the extent of low rainfall agroforestry plantings may be less than desired. This is because there may be additional benefits from agroforestry plantations that are not received or captured by the producers. A variety of benefits, such as salinity reduction, carbon sequestration and increased habitat for native species can be derived from
agroforestry, however, producers receive no financial gain from providing these services and are unlikely to factor them into their investment decisions other than for altruistic reasons.

For example, large scale clearing of native vegetation for agriculture has led to a number of natural resource problems, the most notorious of which is dryland salinity. It is well known that dryland salinity poses a significant threat to agriculture and rural communities throughout Australia. It is felt that the establishment of woody vegetation in low rainfall regions may be a potential part of the salinity control solution. Reforesting parts of catchments affected by dryland salinity may have two benefits – first, the lowering of water tables, and second, improved in-stream water quality. However, it is highly likely that both of these outcomes benefit individuals other than the producer responsible for the revegetation. For example, the benefits of an improved riverine environment might be shared among all Australians to varying degrees. Unless a private landholder captures the full benefits of the revegetation they are unlikely to provide the socially optimal level of planting.

There are many reasons why a private landholder cannot simply negotiate with the other beneficiaries for them to meet part of the cost of revegetation. First, ground water systems are complex, making it difficult to predict with any degree of accuracy what the benefits of revegetation will be. Second, it is often problematic to quantify the nonmarket benefits associated with an improvement in environmental condition. Third, negotiating a payment from numerous parties is difficult and usually involves high negotiation costs. It is in order to overcome these difficulties that the government often intervenes to encourage actions that provide additional environmental services. However, government intervention is not justified in all cases. The benefits of intervention need to be greater than the costs, including the relevant information and administration costs.

Governments have a variety of tools that can be used in these situations such as taxes, subsidies and tradable rights (see ABARE 2001). The level of understanding of these instruments among policy makers, regional NRM groups and landholders is steadily improving through initiatives such as the National Market Based Instruments Pilot Program and other research programs. The quality of biophysical information needed to support the use of these instruments is also improving. Consequently, their use is steadily growing. However, the key point in the context of analysing the commercial viability of the Best Bets products is that although an agroforestry enterprise might provide some environmental benefits to others, they are not normally a factor that should be considered in an assessment of commercial viability. The exception is where some form of government regulation or institutional arrangement is in place that transfers some of the ecosystem service benefits to the landholder. It is then this transfer to the landholder, and not the total value of the improvement in ecosystem services, that should be considered in the assessment of commercial viability.

The effect of research and development on competitiveness

When products are not commercially viable with current technology, R&D is a possible avenue for achieving cost reductions and improving competitiveness. Hague et al. (2007) often mention the need for further R&D to make emerging or subcommercial products viable. Research and development is proposed by Hague et al. (2007) as a way of overcoming some of the technical production issues, particularly for the energy and chemical products. In this section, the main factors that need to be considered when assessing the potential for R&D to improve the relative competitiveness of low rainfall agroforestry are discussed.

Gauging the benefits

In order to understand the benefits that R&D and other activities provide, it is necessary to establish a method to measure the benefits. Measures of consumer and producer surplus can be used to assess the magnitude of benefits from R&D and are illustrated in figure D.
Producer surplus is the total revenue received by producers at the prevailing market price less the costs of production. In figure D, producer surplus is the area above the supply curve (which illustrates how the costs of production increase as aggregate production increases) and below the market price.

Consumer surplus, on the other hand, is a measure of the benefits accruing to consumers. That is, the difference between the market price and the maximum they would be willing to pay (as illustrated by the demand curve in figure D). Consumer surplus is the area below the demand curve and above the market price.

The sum of producer surplus and consumer surplus is termed economic surplus, and this represents the total benefits from trade between producers and consumers.

Research and development that favours all producers

When trying to make emerging or subcommercial products viable, an important question is whether the R&D provides a currently uncompetitive producer with a sufficiently large advantage relative to the producers already in the market. Some of the benefits of the R&D for new entrants will be diluted if existing producers also receive a portion of the R&D benefits. In this case their improvement in relative competitiveness is less than would be indicated by the reduction in production costs due to the productivity gains derived from the R&D. If existing producers receive a benefit equal to that of potential new entrants, then the relative competitiveness will remain unchanged.

Consider the consequences of undertaking R&D with the goal of benefiting low rainfall producers by investigating more efficient methods of converting biomass to electricity. The benefits of this research are likely to be shared by all biomass producers if the research develops a more efficient and profitable way to convert biomass to electricity. Electricity generators are likely to demand more biomass for use in electricity generation, though they would have no preference over low or high rainfall sources. Hence, although prices for biomass may increase, low rainfall producers would not be the only group to benefit.

This is not to say that an investment in this type of R&D does not have the potential to provide net economic benefits (figure E). The R&D investment will have provided a net increase in economic benefits if the aggregate benefits (extra economic surplus) that accrue through time outweigh the costs of the R&D.
In aggregate, producers will gain from any R&D that reduces production costs. This will be the case despite any potential reduction in price as a result of increased supply. If the R&D reduces costs of production, which then leads to an increase in supply and a reduction in market prices, consumers will also benefit. Collectively, these benefits may justify the investment in this R&D. It is uncertain, however, whether low rainfall producers specifically would capture a sizable portion of the benefits – this would hinge on whether their relative cost competitiveness is improved.

International spill overs

Spill overs or leakage of the benefits of R&D is not restricted to competing Australian producers. International competitors can also modify or directly adopt the benefits of Australian R&D. This behaviour would erode the competitive advantage that the R&D was designed to provide to Australian producers, particularly where international trade in the final product is substantial.

In the context of low rainfall agroforestry, a key consideration of spill overs to international producers may be the availability of suitable low rainfall land in major competing countries. The factors that influence the likelihood of spill over effects are discussed in more detail below.

Research and development that favours only low rainfall producers

Advances in production technology or product quality as a result of R&D can result in a shift in demand, supply or both. Consider a low rainfall producer who is uncompetitive in the market because their production costs are too high. By investing in R&D that lowers their costs of production and provides no benefit to competing producers, they could become a profitable producer. In the context of the six Best Bet products, examples of R&D with the greatest potential to favour just low rainfall producers include genetic improvements and silvicultural management specifically designed for the low rainfall environment.

If the entry of a low rainfall producer contributes relatively little to the total supply, there will be minimal impact on the market price. If however, their entry contributes a substantial increase in supply, there will be downward pressure on the market price and this will need to be taken into account.

The key point is that the potential for R&D to create the opportunity for low rainfall producers to enter the market needs to be judged after allowing for any expected change in price due to expanded supply. If their entry to the market will add a very small amount to the overall supply, the benchmark for R&D may be to reduce production costs to less than the current prices. If their entry is expected to have a
negative impact on price, the benchmark for R&D will be more challenging – a larger reduction in production costs may be required for them to become commercially viable.

The ease of technology transfer and, therefore, the likelihood of these spill over effects depend on a number of factors such as:

- the cost of transferring and modifying the R&D versus the cost of undertaking independent research;
- the applicability of the research to other industries, regions or climates; and

There is usually a cost of obtaining and adapting research from another firm, industry or region. If this cost is less than the cost of undertaking independent research there will be potential for spill over effects. Transfer costs can include the cost of obtaining or purchasing the results of R&D. For small industries or business, it will often be less expensive to obtain the R&D results than to create a research program themselves.

The cost of adapting R&D will be higher for industries and regions that are less similar to the industry that was the initial target for the research. For example, a technique developed for harvesting large diameter sawlogs would be more readily adapted to a sawlog producer who focuses on small to medium sized logs, than to a firm harvesting small coppice style bushes.

When considering the applicability of R&D to another region, the different availability of factor inputs can also influence the extent of technology spill overs. For example, one country may have abundant supplies of cheap land in low rainfall areas for which it develops a low rainfall silvicultural technique. This would only be commercially attractive and likely to be transferred to competing producers overseas if they too had access to cheap low rainfall land suited to the new silvicultural regime.

Spill over effects will diminish the improvements in relative competitiveness that a firm or industry can obtain from R&D. This is not to say the R&D may not have positive net economic benefits. As previously mentioned, the benefits of R&D include those captured by both producers and consumers. Hence, rather than estimating the benefits to just a subset of producers, it is the anticipated costs of the R&D, relative to the expected size of the total economic benefits, that dictate whether the R&D investment will be worthwhile for the industry as a whole.

**Undertaking targeted research and development**

From the discussion in the previous section, it is clear that the potential for the spill over of benefits from investments make the task of identifying R&D that might advantage a particular subset of producers a complex task. Research and development undertaken at the early stages of the production process (such as genetic improvements) is generally more likely to provide benefits that the target industry can capture. R&D undertaken further along the production process, such as research into improved harvesting techniques or manufacturing processes, is more likely to benefit all producers of a product (figure F).
An example of R&D focused on the early stage of the production process is the development of short rotation woody crops, particularly oil mallee plantings in Western Australia. Early R&D on these crops have concentrated on tree breeding and production of eucalyptus oil (Abadi 2003). Of course, where processing or harvest techniques and technologies are specific to an industry there may be little spill over of R&D. More recently, R&D has addressed multiple product systems, for example via integrated processing of mallee, for eucalyptus oil, activated carbon and electricity (Cooper et al. 2001; Enecon 2001).

Figure F  Scope to capture benefits of research and development along the production chain.
Revisiting the preliminary assessments of the best bet products

Each of the Best Bet products in Hague et al. (2007) can be characterised as an emerging product or a more extensive use of biomass. In the preliminary assessments of market prospects conducted by CSIRO, a logical first step was to verify the technical feasibility of each product and to scope the size of the markets that they would be targeting. This information was used to draw some conclusions about the potential area of low rainfall agroforestry that industries based around these products could support.

The CSIRO analyses of market prospects seemed to be based on two simplifying assumptions. First, the technology available to existing industries was assumed to be constant. This infers that the productivity of existing producers in the absence of R&D will be constant into the future. Second, although the existence of competing suppliers was noted, their expected level of future production was not explicitly considered. In effect, the initial assessments were conducted with the expectation that today’s market prices will prevail. While this is an overly simplistic assumption it enabled the initial assessments to focus on the existing or potential market size.

Despite the use of the simplifying assumptions, the preliminary analyses of market prospects also proved useful in identifying aspects of the prospects for the Best Bet products that should be subjected to more detailed investigation. For example, in some cases it was noted that there was the potential for supply from competing producers to increase in the future. A more complete analysis would consider the size of the potential increase in supply relative to growth in demand and how this would affect future prices. As R&D was often proposed as a way of overcoming the technical issues related to production efficiency, the possibility of spill over benefits to high rainfall producers must be considered to ascertain whether the technical advances serve to narrow or extend the gap in cost competitiveness between low and high rainfall based industries.

In this chapter, the economic viability of the Best Bet products is reviewed by considering the factors discussed in the previous chapter. In particular, the prospects for future prices are assessed by considering the determinants of demand and supply. The likely distribution of the expected benefits from R&D is also discussed where this is important for enhancing the relative cost competitiveness of the Best Bet products from low rainfall agroforestry.

Products from traditional forest product industries

F1 Appearance grade timber

The conclusion drawn in Hague et al. (2007) is that a low rainfall agroforestry industry producing appearance grade timber is potentially viable in Australia, provided some additional improvements in genetics, silviculture, and processing are achieved.

Demand determinants

The demand side factors affecting the future prospects for a low rainfall appearance grade timber industry are well covered by Hague et al. (2007). Steady growth in income and, to a lesser extent, population should underpin rising demand for appearance grade timber in Australia. Growth in Australia’s gross domestic product is assumed to be 3.0 per cent in 2005-06, compared with 2.3 per cent in the previous year. Over the medium term, the Australian economy is projected to grow at a rate of around 3.3 per cent a year (Penm 2006).

Demand growth in Japan may be more modest as Japanese economic growth has not been as strong as the Australian economy. Economic growth was 2.6 per cent in 2005 and indications are that growth is likely to fall in the medium term to around 1.5 per cent in 2011 (Penm 2006).
It is also thought that demand growth driven by rising incomes would be complemented by growing consumer concern over timber products sourced from native forests (Hague et al. 2007). This may increase demand for plantation sourced wood products, including those from low rainfall regions. These changes in consumer preferences may increase demand, placing upward pressure on prices.

The main obstacle for an economically viable low rainfall industry would seem to be the number of substitute timber sources available. These include both domestic and international native and plantation grown trees. If the alternative sources are not perfectly substitutable in the eyes of the consumer, a low rainfall appearance grade timber may be able to establish a niche market. However, if there is a high degree of substitutability between appearance grade timbers from the competing sources of supply, the economic viability of a low rainfall industry will hinge crucially on its relative cost competitiveness.

**Supply determinants**

Increased supply of Australian regrowth and plantation sawlogs is expected from 2010. The Australian Government’s *Plantations for Australia - 2020 Vision* is a strategy aimed at trebling the 1996 plantation area by 2020. It is aimed at increasing both softwood and hardwood plantations over the next twenty years. With expected increases in hardwood availability over the medium term, the supply of appearance grade timbers may also increase.

Supply of appearance grade timber could also increase if softwoods and panel products continue to capture an increased share of the structural timber market, forcing existing hardwood producers to turn to the hardwood appearance grade timber market. The effect of more produce being directed to the non-structural timber market would be downward pressure on prices.

Internationally, the major world producers of non-coniferous sawnwood in 2004 were the USA (producing 27.9 million cubic metres), Brazil (15.9 million cubic metres), Indonesia (6.1 million cubic metres), India (6.0 million cubic metres), Malaysia (5.6 million cubic metres) and China (4.9 million cubic metres) (International Tropical Timber Organization 2004). Australia, on the other hand, produced 1.0 million cubic metres of sawn hardwood in 2003-04 (ABARE 2005).

While much of the current production in China, Malaysia and Indonesia is sourced from native forests, this resource is also under pressure from environmental interests, and large areas of hardwood plantation are coming on stream as a replacement. Hardwood plantations in these countries (except Malaysia) are considerably larger than those in Australia (FAO 2002). Increased supply from these countries could place downward pressure on hardwood prices.

While it is difficult to reach a definitive conclusion about the production cost difference between high and low rainfall producers without more detailed investigation, there is information available suggesting that it may be substantial. It has been noted that timber produced in low rainfall regions is slow growing and of poor dimensional form (Hague et al. 2007). The average growth per hectare per year is expected to be 5 cubic metres for trees grown in low rainfall regions, compared with 14-56 cubic metres for high rainfall zones (Burns, Walker, Hansard 1999). This slower growth requires a rotation length of 35 years, compared with 10-15 years for high rainfall zones (Burns, Walker, Hansard 1999). Plantation costs of low rainfall zones are also likely to exceed those of high rainfall areas given the higher management and maintenance costs resulting from longer rotation periods.

The small dimensional size of low rainfall logs will also mean lower recovery rates. The smaller the diameter of a log, the less volume is recovered in square sections and the lower is the recovery rate (Love, Yainshet and Grist 1999). This will most likely lead to higher production costs for a low rainfall producer compared with high rainfall producers.

In addition to competing with high rainfall plantation timber, the low rainfall appearance grade timber industry will also need to compete for land with traditional agricultural activities in the low rainfall zones. To secure access to the necessary land resources, returns from low rainfall agroforestry would have to be at least as great as the alternative land uses. Due to the absence of any direct comparison of
returns from specific silvicultural regimes with agriculture, it is difficult to predict the economic viability of a low rainfall industry.

**Research and development**

As mentioned by Hague et al. (2007), future productivity gains assume considerable importance if low rainfall producers are to narrow the gap in competitiveness and maintain that position relative to higher rainfall plantations and overseas producers. In this context, the research being conducted by the Australian Low Rainfall Tree Improvement Group (ALRTIG) and the Joint Venture Agroforestry Program (JVAP) could have an important role to play in improving the relative competitiveness of a low rainfall industry.

The benefits of genetic improvement and advanced silvicultural regimes specific to low rainfall appearance grade timber are likely to be captured primarily by the low rainfall industry. However, the benefits from additional work on issues such as gluing, machining and stability, and markets for residues are more likely to spill over to high rainfall competitors. Generally, R&D undertaken at the early stages of the production process is more likely to provide benefits that the low rainfall industry can capture. R&D undertaken further along the production process, such as research on harvesting techniques or manufacturing processes, is more likely to benefit all producers of a product.

**Implications for a low rainfall agroforestry industry**

Conclusions from Hague et al. (2007) that the low rainfall industry may capture a substantial share of the appearance product market appear mostly speculative. While a low rainfall industry may be technically feasible, there are serious doubts over its ability to compete with high rainfall forestry producers and other non-forestry land uses.

**F2 Dry formed fibreboard**

Although not explicitly mentioning the future price of medium density fibreboard (MDF), the preliminary analysis of the prospects for dry formed fibreboard adequately covers the main market developments likely to constrain the emergence of a viable industry based on a low rainfall resource. These revolve around the future growth in demand, and the prospects for considerable increases in supply from overseas competitors.

MDF is produced in Australia for both domestic consumption (457 000 cubic meters in 2004-05) and, increasingly, for export markets (365 000 cubic metres in 2004-05). The major markets for Australian MDF exports are China (taking 35 per cent), the Republic of Korea (26 per cent) and Japan (12 per cent) (Davidson and Hanna 2004).

**Demand determinants**

Consumption of MDF is largely in the building and furniture industries where demand is strongly affected by income growth and economic activity. As discussed previously, income growth in Australia is expected to be steady over the coming decade. Economic growth in Australia’s major markets, with the exception of Japan, is also expected to be strong and generally above the world average. China in particular is one of the world’s fastest growing economies, averaging growth of 10 per cent a year in gross domestic product since 1990 (International Monetary Fund 2006).

In 2004, the Australian MDF industry was operating at around 80 per cent of total capacity, on average (DAFF, unpublished). Production of MDF only rose slightly from 786 000 cubic metres in 2002-03 to 795 000 cubic metres in 2003-04, and was virtually unchanged in 2004-05 (ABARE 2005). Consequently, some excess capacity probably still exists within the Australian MDF industry to meet any future increases in demand.

If demand did increase to a point where additional investment in Australian production capacity may occur, then the pivotal factor dictating where this investment is likely to be made is the cost competitiveness of high and low rainfall feedstocks. Because the lowest estimate of the cost of low rainfall feedstock for fibreboard production is at the top end of the range for similar feedstock from
high rainfall regions (Hague et al. 2007), this immediately casts some doubt on the cost competitiveness of a low rainfall industry.

**Supply determinants**

As noted earlier, the higher costs of production for low rainfall regions are due to slower growth rates and poorer recovery rates. A case study conducted by Stucley et al. (2004) concluded that a low rainfall based plantation in the Murray Darling Basin (MDB) would require 60 per cent more area to provide the same level of biomass as a high rainfall plantation in south east Queensland. For the low rainfall generated biomass to earn the same internal rate of return on investment as the high rainfall biomass, the stumpage price needed to be 10 times greater than the high rainfall stumpage price. For short rotation crops the gap in costs was not nearly so wide with MDB plantings requiring a stumpage value only two and a half times that of the high rainfall stumpage price.

The prospects of the low rainfall industry emerging as a cost competitive supplier are further dampened by a combination of expected supply side developments. The domestic availability of high rainfall softwood feedstock is projected to increase over coming decades, though at a slower pace as we approach 2044 (Ferguson et al. 2002). This is compounded by the prospects of significant increases in softwood supply from New Zealand in the medium term (New Zealand Ministry of Agriculture and Forestry 2006). New Zealand MDF producers will therefore be in a good position to meet future demand with a plentiful supply of near optimum wood material (radiata pine) at very competitive cost of supply. Intense competition in the MDF market is also expected from both international fibreboard producers, and other fibre sources.

**Research and development**

Research focusing on genetic improvement and/or advanced silvicultural regimes specific to low rainfall timber for MDF production is a good example of research that is likely to have few, if any, spill over benefits to high rainfall competitors. What remains unclear, however, is the extent to which this research would spill over to international competitors in other low rainfall regions, and the likelihood that this R&D will make low rainfall agroforestry competitive with existing agricultural land uses.

**Implications for a low rainfall agroforestry industry**

In the light of the market developments and the early stage of low rainfall production research, the goal of 10 per cent penetration into the Asia Pacific dry formed fibreboard market seems to be more of an aspiration than an achievable goal. As Hague et al. (2007) note, a commercial use for some or all of the remaining biomass will probably be needed to lower the cost of the wood chip to the MDF manufacturer if investment in processing is to be attracted to a low rainfall area.

**F3 Wood-plastic composites**

Hague et al. (2007) present a very comprehensive review of the prospects of wood-plastic composite (WPC) products accounting for all relevant factors likely to affect the future viability of this industry. Their analysis of future prospects is made more difficult by the absence of Australian market data for these products. Consequently, they focused on the potential size of the Australian market. The total market for products like windows, doors, facias, architrave and decking is estimated to be around $5 billion a year. Capturing a small share of this market and the development of some export opportunities would provide the basis for the creation of a significant new industry in Australia.

**Demand determinants**

Wood-plastic composites are thought to have advantages over traditional timber products due to a mix of consumer preference, legislation (in the United States) and product performance attributes. These attributes include a reduced health risk (compared with treated timbers), lower maintenance costs, stability and resistance to biodegradation. In the United States the demand for wood-plastic composite
products has grown at an average rate of 10 per cent per year, enabling the emergence of a viable industry (Freedonia 2002).

Supply determinants

The small scale of manufacturing facilities works both for and against the development of a viable low rainfall WPC industry. On the positive side, a relatively small agroforestry estate would be required to provide the feedstock for a WPC facility. However, this may be counterbalanced by the attractiveness of alternative sources of wood residues such as sawmills in high rainfall regions. Plants located in urban areas may also have a freight advantage with respect to obtaining plastics and the proximity to end-use markets.

Research and development

While the cost competitiveness of low rainfall feedstock will again be a key factor determining the viability of a low rainfall industry, Hague et al. (2007) raise some issues that could be better understood with additional R&D. These include the performance of WPC products in the Australian environment, particularly how they are affected by UV light. The suitability of alternative sources of wood residues, including those from low rainfall agroforestry, was also listed for further investigation.

Implications for a low rainfall agroforestry industry

If successful, both of these R&D activities are likely to deliver benefits to all producers of wood residues. However, these are examples of R&D that may be justified by the sum of the potential increase in producer and consumer surplus. That is, the costs of the R&D may be justified by the potential benefits even though it is possible that none of the benefits may be captured by low rainfall producers.

Energy and chemical products

E1 Electricity generation from woody biomass

According to Hague et al. (2007), electricity generation from biomass suffers from poor economies of scale and lower technical efficiency. It is likely to be feasible only if the residues are available at zero cost from other processing activities. Under favourable conditions, co-fired biomass generation seems competitive with other forms of renewable energy. However, the potential for biomass generation largely depends on the Mandatory Renewable Energy Target (MRET) policy. Research and development required for the viable generation of electricity from biomass are centred on the need for more efficient and proven technology.

Demand determinants

Steady economic growth and a larger Australian population are expected to lead to a steady increase in demand for electricity in the medium to long term. In recent years, consumption has increased at a rate of around 2 per cent a year and is forecast to continue increasing by an average 2.1 per cent a year to 2030 (Akmal and Riwoe 2005). The Australian Government MRET, by establishing a set of targets for the use of renewable energy sources in the production of electricity, creates additional demand for this source, possibly placing upward pressure on prices of renewably sourced electricity and therefore biomass feedstocks. The target for renewable energy sales in 2002 was 1100 gigaWatt hours, rising to 9500 gigaWatt hours by 2010 (Short and Dickson 2003). Renewable energy as a whole is expected to grow by 4.1 per cent a year to 2010 and then by 2.4 per cent to 2030. The majority is sourced from hydroelectricity while wind energy is expected to undergo the highest growth.

Despite the influence of the MRET, the market for renewably sourced energy is relatively small. However, consumers are willing to pay a price premium for such energy but prefer renewable sources other than trees for energy generation. In addition, renewably sourced energy cannot currently
compete with low cost fossil fuels on economic grounds and consumer preferences are not sufficiently strong to make high cost renewable generation options economic.

**Supply determinants**

Biomass constitutes only a small part of a large market. In 2003-04, it represented less than five per cent of renewably generated electricity and under half a per cent of the entire electricity market. In contributing such a small portion in a large market, it is unlikely that changes in the supply of electricity generated from woody biomass would change the market price.

As noted in the previous chapter, other key determinants for supply are changes in production costs and productivity — a productivity gain is equivalent to a reduction in production costs. The investment cost for wind power facilities is projected to fall significantly in the next 10 years, reducing average costs by 35 per cent (figure G) (Passey 2003). In effect, wind power producers will be willing to offer greater supplies to the market at each price level. This same decrease in costs is not expected for forest residue and wood waste (Short and Dickson 2003). With the portion of renewable electricity expected to be generated by wind technology to rise from around five per cent to more than twenty per cent in 2030, further increases in supply of wind generated electricity are likely to put downward pressure on renewable electricity prices.

![Wind energy cost estimates](image)

**Figure G  Wind energy cost estimates**

The higher costs associated with servicing regional areas with the national electricity grid may provide some validation for small scale biomass generated electricity plants, particularly when electricity is produced in conjunction with an associated forest industry (Hague et al. 2007). Some work has been done on integrated mallee processing where the integrated production of eucalyptus oil, activated carbon and electricity are sourced from the biomass of short rotation oil mallee crops (for further detail, see Enecon 2002 and Cooper et al. 2002). Again, with the large size of the entire electricity market it is unlikely that an increase in supply from a regional provider will impact greatly on prices.

**Research and development**

Research and development required for the viable generation of electricity from biomass are centred on the need for more efficient and proven technology. However, the benefits of any further R&D to improve the technology for conversion of woody biomass to electricity would not be limited to low rainfall producers. This means that low rainfall producers will receive no relative advantage over high rainfall producers.
**Expected price trends**

There are a variety of factors in the market for renewable energy that will exert upward and downward pressure on prices, therefore making it difficult to determine price trends. Increases in the demand for renewable energy are expected with income and population growth and the MRET scheme, placing some upward pressure on prices. However, counteracting this are the potential productivity gains from major renewable energy competitors (such as wind generated electricity) as markets for renewable energy expand and these technologies take advantage of economies of scale.

**Implications for a low rainfall agroforestry industry**

While the production of electricity from biomass co-fired with coal or bagasse is a competitive source of renewable electricity generation, electricity generated solely from woody biomass is not. Short and Dickson (2003) ranked the different technologies in terms of increasing long run average costs (figure H). The co-firing of biomass with coal ranks as the second lowest cost technology, and wood waste co-fired with bagasse ranks third. Generation based solely on forest residue and wood waste, however, ranks fourteenth of the 23 technologies listed, and is not considered commercially viable (Howard and Olszak 2004).

While the cost of producing renewable energy may fall in the medium term, it is possible that an increase in the MRET target would allow higher cost technologies to be employed to achieve the target. While this may lead to expanded use of competitively priced options such as biomass co-fired with coal or bagasse, it is unlikely to increase the prospects for electricity generation from biomass alone, given its much higher costs.

From the perspective of the low rainfall industry, the important question is whether a low rainfall industry could supply the feedstock at a lower cost than could their high rainfall competitors. As noted earlier, while this is unlikely to eventuate from long rotation crops, short rotation enterprises in low rainfall zones have a greater probability of being able to do so.

![Figure H Average cost of electricity generation, 2000](image)

**Figure H Average cost of electricity generation, 2000**

**E2 Ethanol and methanol**

Preliminary analysis of conversion of biomass to ethanol or methanol suggests that even if technical issues regarding production efficiency can be overcome, industries based on a low rainfall source of feedstock would still likely be at a great disadvantage relative to fossil fuels, as are a majority of feedstocks. Beyond this, a low rainfall industry would face strong competition from these other possible feedstocks, such as high rainfall biomass and alternative crops.
Published information on the demand prospects for ethanol and methanol in non-fuel applications are difficult to find; consequently, only ethanol and its use as an alternative fuel are considered here.

**Demand determinants**

Growth in Australian income and population levels generally increases demand for transport fuel over the medium to long term. Akmal and Riwoe (2005) forecast energy consumption by the road transport sector to increase by an average of 2 per cent a year to 2009-10 and from then by 1.9 per cent to 2029-30 (figure I). The increase in consumption for the more ‘environmentally friendly’ source of LPG is growing at a faster rate than other transport fuel sources (predominantly petroleum products).

![Australian road transport energy use](image)

**Figure I  Australian road transport energy use**

Ethanol used in the transport market is a particularly clear example of a product with a readily available substitute, that is, petrol. While increasing awareness and responsiveness of consumer sentiment to environmental issues may give rise to an increased interest in alternative fuel sources, generally the main demand factor will be ethanol’s competitiveness relative to petrol.

Crude oil prices have risen recently to around US$70 a barrel, driven by strong growth in demand and Middle East security concerns. Prices are expected to remain high in 2006 before a marginal reduction in 2007 as a result of expected increases in both world oil production and spare production capacity (figure J) (Kinsella et al. 2006). Higher oil prices mean that alternatives, such as ethanol, become more attractive and enjoy an increased demand.
Government policy, such as the Biofuels for Cleaner Transport program directed at production and distribution of transport fuel is also likely to enhance the demand for alternatively sourced fuel. Vehicle standards post-2006 requires progressive fuel efficiency in petrol vehicles with the use of higher octane petrol. This may improve the future viability of ethanol, via either increased production costs of petrol or increased opportunities for ethanol use as an octane enhancer (CSIRO, BTRE and ABARE 2003). Such an increase in demand would place upward pressure on the price of ethanol and therefore feedstocks used in ethanol production.

Government policy also affects demand in this market through the various excise arrangements. Currently, biofuels (ethanol and biodiesel) enjoy full excise relief through the Production Grants Scheme meaning that they have a 38.143 cent per litre price advantage. Such a price advantage increases demand for these products relative to traditional fuels. However, with the introduction of Fuel Tax Reforms (Australian Government 2005a), this excise relief and price advantage will diminish after 2010-11 with the introduction of alternative fuel excise.

**Supply determinants**

The size of the road transport fuel market means a major new ethanol producer would have little effect on the market price. Given that price effects would be minimal, the supply of ethanol from woody biomass would depend on the production or processing costs of ethanol using different feedstocks and the costs of purchasing these feedstocks.

To date, ethanol is not a major source of transport fuel. The ethanol that is used has been produced from the fermentation of sugar from either wheat starch or molasses. In 2002-03, around 75 million litres of fuel ethanol was produced. Since then, production has dropped to around 23 million litres, less than 0.1 per cent of the automotive gas market (Australian Government 2005b).

Currently, there are several government programs subsidising the production of alternative fuels, such as the Energy Grants (Credit) Scheme (EGCS) and the Capital Grant Program. Whilst such programs increase supply, the EGCS will be phased out with the Fuel Tax Reforms and these schemes are not source specific. They are available to any feedstock and would then provide no competitive advantage to low rainfall products.
Table 1  Costs of production for ethanol a

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Feedstock cost (cents per litre)</th>
<th>Net required revenue b</th>
<th>New capacity c</th>
<th>Existing capacity d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste starch</td>
<td>10</td>
<td>26</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Sorghum/Feedwheat</td>
<td>40</td>
<td>36</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>C molasses</td>
<td>18</td>
<td>33</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>B molasses</td>
<td>33</td>
<td>48</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>A molasses</td>
<td>56</td>
<td>71</td>
<td>63</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- **a** Based on ABARE estimates.
- **b** The minimum revenue required to make ethanol production commercially viable.
- **c** Includes capital and other operating costs and any by-product revenue, where relevant.
- **d** Includes revenue from by-products.

Assuming that viable technology is available and wood biomass costs are zero, the total cost of producing ethanol from lignocellulosic material is an estimated $0.31- $1.50 a litre (Hague et al. 2007). Table 1 presents the costs of alternative sources of feedstocks for ethanol production and the ethanol selling price required for the feedstock to be an economically viable source (the net required revenue). The net required revenue will differ depending on whether there is existing infrastructure to manufacture these fuels (in which case this capital is a sunk cost) or whether new investment is required in capacity (in which case a rate of return of 7 per cent a year is assumed).

Based on these estimates, the cost of ethanol production from lignocellulosic materials is much higher than most other alternative feedstocks. Therefore, even if the ethanol price means production with woody biomass is economically viable, woody biomass is unlikely to be the choice feedstock.

**Research and development**

While R&D which overcomes the difficulties in converting pentose sugar into ethanol or biomass into methanol may make such operations viable through reduced production costs, these advances will not improve the situation of low rainfall producers. Any benefits that such technological improvements provide will also be available to high rainfall producers. Low rainfall producers will have no change in their competitive position relative to high rainfall producers.

**Expected price trends**

Increases in demand for renewable fuel sources are anticipated over the long term in response to income and population growth and government policy. Supply of renewable fuel is also expected to increase, driven largely by government funded initiatives. However, this relatively small supply increase is unlikely to have an impact on prices. While oil prices are anticipated to fall, the cost competitiveness of different sources of feedstock, rather than any price changes, will be the principal determinant of which feedstocks are used.

**Implications for a low rainfall agroforestry industry**

Current government initiatives for renewable fuel sources are not source specific, so producers using alternative feedstocks such as sugar and crop residues are likely to enter the market ahead of producers using woody biomass if market prices improve. Those producers have the advantage of both lower cost feedstock and more efficient production technology. CSIRO, BTRE and ABARE (2003) conducted a study on biofuels contributing to the total fuel supply by 2010. An updated version of this analysis (Short and Riwoe 2005) determined that the price – relative to petrol – that ethanol could expect to receive in the market (termed the *threshold price* in each report) would decrease in real terms from around 70 cents per litre to 30 cents per litre in 2015-16. Comparing this to the figures in table 1, only some relatively cheap feedstocks, such as sorghum and C molasses, will stay viable in the long run.
Consequently, the conclusions reached by Hague et al. (2007) that ethanol produced from woody biomass is unlikely to be able to compete with other fuel sources is expected to hold.

**E3 Pyrolytic bio-oil**

The primary use of pyrolytic oils is in electricity generation with some additional potential to substitute for diesel. Even though bio-oil production can be coupled with electricity generation to reduce the costs of production, it is unlikely to be cost competitive and would face competition from a high rainfall based industry.

As detailed by Hague et al. (2007), pyrolytic bio-oil production does not appear to be commercially feasible with current technology. It is also apparent that there are major technical impediments to the production of some of the high value products from bio-oil. As with some of the products considered earlier in this chapter, a low rainfall pyrolytic oil industry would also face considerable competition from alternative woody feedstocks, particularly processing waste and high rainfall woody biomass.
Implications for the choice of research and development

The presence of technology spill overs and the fact that the low rainfall agroforestry sector will have to compete directly with many other alternative sources of biomass, particularly high rainfall forest plantations, makes identification of R&D that will facilitate the emergence of a viable low rainfall industry a complex task.

In general, R&D on processes that convert biomass into building materials or energy and chemical products are likely to favour all producers who could provide feedstock to that market. The change in per hectare returns for all producers may lead to greater total benefits for a high rainfall producer as a result of their higher biomass yields.

In contrast, there may be some potential for R&D to improve the relative cost competitiveness of low rainfall producers in areas where there are potentially fewer spill overs. Examples include genetic improvement and silvicultural management customised to low rainfall environments, as well as the development of short rotation species such as oil mallee and *Acacia*.

As mentioned in the previous section, the merit of these types of R&D will critically hinge on an assessment of whether the R&D can be completed successfully and deliver cost reductions of sufficient size to eliminate the current gap in cost competitiveness. Ethanol production is viable in the medium to long term if production costs are below $0.30 a litre. Yet the cost of ethanol production from biomass is estimated at $0.31-1.50 a litre. R&D of the technology required to convert biomass to ethanol would thus need to create cost savings of up to $1.20 a litre.

There are reasons, however, why commercial viability should not be the only benchmark or target for R&D. Revegetation and the establishment of subcommercial forest plantations can provide benefits to downstream resource users by mitigating dryland and instream salinity, as well as nonmarket benefits to society more broadly by improving environmental protection. Heaney, Beare and Bell (2000) concluded that a targeted approach to reforestation has the potential to be a cost effective instrument for managing dryland salinity, although this depends on the hydrological characteristics of a catchment. In this context, while R&D may not make low rainfall agroforestry commercially viable against competing land uses, it may provide benefits to society by reducing the opportunity costs of salinity mitigation. In addition, R&D provides benefits to consumers and other producer groups, and these benefits need to be compared to the costs of undertaking the R&D.
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Dryland salinity poses a significant threat to agriculture and rural communities throughout Australia. The establishment of woody vegetation in low rainfall regions has been identified as a possible option for mitigating land salinisation in Australia. RIRDC funded the Best Bets for Biomass project to investigate the markets and prospects for six selected products that could be produced from low rainfall grown woody biomass.

This report discusses some of the supply and demand factors likely to affect the future competitiveness of the six best-bet low rainfall agroforestry industries. The report then extends the preliminary market evaluations that have been undertaken by CSIRO in 2007.

The report also provides an in-principle analysis of the types of Research and Development that could increase the returns to landholders considering low rainfall agroforestry.

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