Bio Energy Commercial Agricultural Pellet Proposal (BECAPP)

Phase 1 Feasibility Study

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TABLE OF CONTENTS

Introduction

This Feasibility Study evaluates the viability of a grass-based pelleting operation in the Rainy River District. The information used in this study comes from publicly available sources (Internet), discussions with industry experts, and from input from Bio Energy Commercial Agricultrual Pellet Proposal (BECAPP) members.

The **BECAPP Model** filters all the available information and provides a general forecast of the economic viability of the project. Since it is a dynamic model, data inputs can be altered for various scenarios. The **Model** is in the form of an EXCEL spreadsheet, provided separately.

The "bullets summary" at the end of each section summarize the most pertinent information taken from the information search. Where applicable, the values summarized in the bullets, for example yield data, are the values used in running the **BECAPP Model**.

The **List of References** at the end of the study identifies the sources of the information used in the study.

Bio Energy Crops

There are a variety of agricultural grasses that could potentially be utilized for bio energy fuels: switchgrass (*Panicum virgatum*), reed canary grass (Phalaris arundinacea), prairie grass (Spartina pectinata), big blue stem (Andropogon gerardii), miscanthus (*Miscanthus x giganteus*), corn (*Zea mays*), winter canola (*Brassica napus*), winter wheat (*Triticum aestivum*) oil seeds, and hemp (Cannabis sativa) (***ref:1,2,****3*). These materials may be grown specifically as bio energy crops or may be by-products of other agricultural processes such as grain or oil seed production.

Wood residues from logging and milling operations (branches, chips, sawdust, bark, mill waste ("hog fuel")) are the most widely used bio energy fuels. "Purpose-grown" willow and poplar is currently of interest as a source of fibre for fuel energy. Purpose-grown fibre is similar in concept to agricultural bio energy grasses in that it is grown as a crop and is not a residue. ***(ref: 4)***

Bio energy materials can be burned directly as loose fuel or baled residues. Compressing into briquettes, fuel "pucks", or pellets increases density and improves hauling and combustion characteristics.

The combustion characteristics of bio energy fuel vary with respect to moisture content, energy values, ash and chemical composition, and emissions. These variations are discussed under the **Comparison of Fuels** section.

Trials on switchgrass, reed canary grass, prairie grass and miscanthus have been undertaken in the Rainy River District. At the time of writing, the only local yield data available was from small test plots conducted at the Emo Agriculture Research Station ***(ref:***

5). A rough average yield was determined from the data available. In 2009, larger test blocks were planted on farms in the Rainy River area. Yield data for these trials has not yet been compiled.

Hay yields on good land in the Rainy River District range from 3-3.5 tonnes of dry matter per acre (7.4 tonnes- 8.6 tonnes per ha)(***ref: 6***). One of the objectives of a conversion to bio energy crops is to allow for use of more marginal crop land. A conservative estimate for yields of bio energy crops from more marginal crop land, based on experience with hay yields, would be in the 2-2.5 tonnes/acre (4.9 – 6.2 tonnes/ha) range***.(ref: 6)***These yields are conservative as compared those of switchgrass and reed canary grass trials in eastern Ontario and Michigan's Upper Peninsula.

For the purposes of this Study, conservative estimates of expected yields based on the EARS yield data, estimates based on yields from other grass crops, and the most reliable information from trials in other areas was used in the **BECAPP Model.**

- Switchgrass and reed canary grass are the crops considered in this Study
- Yields estimates are 4 – 8 tonnes per ha ***(refs:7-14)***

Status of Grass as a Bio Fuel

A comprehensive review of available information was conducted on the utilization of agricultural grasses as a bio energy crop.

There have been many studies and trials conducted on the use of switchgrass and reed canary grass as fuels. A listing of the trials and studies used in this feasibility study is found in the **List of References**.

Whereas combustion of wood residues is common, both in unprocessed and pellet form, grass-based fuel, particularly pelleted grass fuels, is still in experimental and trial stages. Small scale or prototype pelleting machines were used to make the pellets in the studies identified. Equipment manufacturers who provided quotes for this study indicated that their focus markets were primarily wood pellets. They had not sold any equipment for commercial grass pelleting but could provide lab trials using agricultural grasses. There is currently no commercial pellet equipment in North American designed specifically for reed canary grass (***ref: 15***)

Pellet fuel heaters are commonly available for domestic, and in some cases, small-scale industrial use. There are currently no companies manufacturing stoves specifically for burning grass pellets (***ref:16***) Almost all models use exclusively wood pellets. Only those designed to burn corn as a fuel are capable of burning grass-based pellets. The technology required for this fuel is called "close couple gasification". It is a requirement for combustion of high ash fuels to reduce the formation of "clinkers" or hard mineral deposits which cause fouling***. (ref: 17).*** The issue of clinker formation also applies to large industrial boilers used for co-generation. ***(ref:11)***

North American pellet standards identify "premium" grade pellets and "standard" grade (or "industrial" grade) pellets (***ref: 18***) . The main difference between the two is ash content. Standard grade fuel is usually up to 3% ash content, while premium grade is less than 1 percent. Standard pellets can only be burned in appliances designed to burn the higher ash content pellets

The European Union has recently come out with new standards for pellets. Class A1 is the best quality for private use with an ash content of less than 0.5% (from conifers) and less than 0.7% from other types of wood. Class A2 covers the wider spectrum of raw materials with an ash content of up to 1%. Class B, originally designated as "industrial" pellets allows for a higher ash content. Depending on the raw material, Class B signifies an ash content of greater than 1%. (***ref: 19***) For more on European standards, see the **Current Market Conditions** section.

- Switchgrass is 4% ash ***(refs: 14, 20, 21)***
- Reed canary grass is 7% ash (***refs: 9, 11, 22)***
- Wood fiber is 0.6% ash ***(ref: 22)***

Area of Interest

The area of interest for this project was identified by members of BECAPP at a meeting held on September 24. The area encompassed Rainy River to Fort Frances plus the farmland north to Morson. It was stated that an estimated 20 to 30 farmers in the Rainy River District might be interested in bio energy crop production***.(ref: 6)***

There are approximately 130,000 tillable acres (53,000 ha) in the Rainy River District. It was estimated that approximately 30,000- 50,000 acres (12,000 – 20,000 ha) might be considered for conversion to bio energy crops for the purposes of this Study.

- 6,000 to 20,000 ha will be considered for conversion to bio energy crop for the purposes of this Study. (see **Future Options** section)

Establishment and Harvest Costs

General establishment and harvest costs were interpolated and summarized from studies done in other areas to allow for an overall prediction for the Rainy River District. There are technologies that can improve the profitability of harvest operations (large bales, loafing ***(refs: 23, 24***)). For the purposes of this Study, it is assumed that producers will use standard haying equipment.

Both switchgrass and reed canary grass provide a single crop per year. It takes about 3 years to establish optimum growth.

Studies have looked at the option of fall harvest and baling vs fall harvest and spring baling. While the latter may improve the combustion quality of the grass (lower ash content, drier material), the logistics of spring operations may prove impractical (***ref: 8***). In studies of reed canary grass, over-wintering prior to harvest resulted in up to 100% loss of harvestable yield ***(ref: 15***)

For the purposes of this Study, land rental costs were not included in the consideration of overall establishment and maintenance costs. Establishment includes site preparation, seeding, and herbicide treatment. Annual maintenance costs include fertilizer and labour costs. Harvest costs include mowing, baling (standard bales), stacking, and tarping. These variables can be updated in the **Model** with more up-to-date information as it becomes available.

The prices paid to producers for agricultural grass are market driven and can only be estimated for the purposes of this study. In the Rainy River District, hay prices are conservatively estimated in the $80/tonne range (***ref: 25***). Local area producers have indicated that prices in the range of 4 to 5 cents per pound baled hay ($133.95/tonne) would be required to justify making a switch from cattle farming to fuel grass farming. (***ref: 25***). This value is assumed to be the price paid to the producers for the purposes of this study and is used in the **Model** as the farm gate price for baled fuel grass.

- Establishment costs estimates: $460/ha (***refs: 13, 21, 25***)
- Annual maintenance costs estimates: $157/ha ***(refs: 13, 21)***
- Harvest costs estimates: $38/tonne (***refs: 13, 17, 23***)
- Farm gate price of baled fuel grass: $134/tonne (***ref: 25***)

Transportation

Some of the studies looked at mobile pelleting operations. Small-scale, prototype units were used in these studies (***refs: 3, 26***) . In one study, a stationary unit was retrofitted to be transported on semi trailers. (***ref: 7***) The studies show that field pelleting has not proved economically feasible on a commercial scale (***ref: 27***).

With respect to the BECAPP project**, t**he main constraint to mobile pelleting was the limited output capacity of a mobile unit and the total volume of grass to be processed each year. In addition, pellet quality specifications are more difficult to manage under these circumstances. The mobile units used in the studies did not include a bagging function. The main issues limiting the economic feasibility of field pelleting were low capacity of mobile units, high energy consumption, heavy weights and variable moisture content of the grass. (***ref: 27***)

An interesting “rule of thumb” that emerged in one of the studies was that cost of transportation exceeds the value of the energy of the raw biomass if transported more than 100 km (***ref: 7***). This places field operations within about a 100 km radius of a pelleting plant for economic viability.

It is assumed that a pellet plant would be constructed in a central location and baled grasses delivered to the plant. It is also assumed that a limited inventory of bales would be maintained at the plant. Producers would stockpile their crops and deliver as required.

This study assumes that standard haying equipment will be used. In the Rainy River District, this would include round baling. A payload of about 20 tonnes is assumed for round bales (***ref: 25***).The cost estimates from the various studies reviewed in the preparation of this study assumed harvest and transportation costs of standard bales, not round bales. Standard bales are lower density and would only allow for transportation of approximately 9 tonnes per payload (***ref: 25***). An "average" payload of 14.5 tonnes is used in the **Model** for ease of evaluation only. An average transportation cost of $9/tonne is calculated using this average payload. In addition, an average distance of 55 km from field to facility is assumed for ease of evaluation. This can be altered in the **Model** depending on the individual producer's actual distance from the facility. Using average values gives an overall picture of the costs involved in a project of this size.

- Average transportation cost estimate: $9/tonne (***refs: 13, 17, 23, 25***)
- Average truck payload: 14.5 tonnes ***(ref: 25)***
- Average transportation distance: 55 km
- Trucking rate: $80/hour (***ref: 25***)

The Pelleting Process

Pelleting operations generally require the following process steps: drier, coarse grinding ("bale buster"), fine grinding (hammer mill), conditioner, pelleter, cooler, screening, bagging, palletizer (stacking of bags), wrapping of pallets. (***ref: 3***)

There is some variation between equipment manufacturers allowing for a reduced number of process steps depending upon the equipment selected. For example, some manufacturers have technology that can eliminate the conditioning and cooling steps.

The main difference between pelleting of grass and wood residues is the drying process. Wood residues usually are in the 50% moisture content range, the result of being stockpiled outdoors. Agricultural grasses are in the 10-18% moisture content range. Drying is usually not required.

A review of the studies published on line identified a very divergent range of pelleting equipment costs. The costs varied for a variety of reasons: some trials involved model-based calculations only, some trials use bench-top pelleting equipment, some trials were based on pelleting materials other than agricultural grasses, some trials did not include all processes (drying, screening, bagging etc). The best-estimate average from five different studies, excluding mobile pelleting equipment, was calculated to be $64/tonne for equipment costs (***refs: 1, 14, 26, 28***).

A number of equipment manufacturers were contacted directly for quotes for "turn-key" operations in a range of sizes up to 100,000 tonnes per year. Manufacturer quotes are believed to provide more realistic equipment costs for this particular project than small scale trials and studies.

At the time of writing, 4 manufacturers provided quotes. Only PSI International (New Brunswick) and Kahn SARJ Equipment (Germany) provide turn-key operations quotes.

Turn-key quotes included all costs associated with the construction of a pelleting operation including a building, project management, all equipment, all utilities.

- For 100,000 tonnes/year: $6.2 M capital cost ***(ref: 29)***
- For 35,000 tonnes/year: $2.24 M capital cost ***(ref: 29)***
- For 50,000 tonnes/year: $6.8 M capital cost (***refs: 29, 30***)

- Average turn-key capital cost estimate from quotes: $87/tonne

A review of the studies published on line identified a very divergent range of operating costs. The best-estimate average from five different studies, excluding mobile pelleting equipment, was calculated to be $47/tonne for operating costs (***refs: 1, 13, 14, 23***).

At the time of writing, only PSI and Kahn provided estimates of operating cost with their equipment quotes. Operations cover supplies (bags, pallets), utilities, insurance, and labour (assumes 4 to 8 employees). The manufacturers' quotes are likely a more realistic reflection of operating cost than the operating costs identified in the studies. However, there is a wide variation between the quotes. Since operating costs have a huge impact on the profitability of a pelleting operation, a more realistic estimate would have to be determined when specific engineering designs are selected. Using average values of the two quotes in the **Model** gives an overall picture of operating costs.

- For 33,000 tonnes/year: $71/tonne operating cost ***(ref: 29,30)***

Some of the grass is lost in the pelleting process. In a commercial-scale pelleting operations, the pellets are screened and the fines are re-entrained in the pelleting process. There is some loss in the conversion from grass to pellets. A review of the studies published on line identified a range of recoveries, from 52% (without re-entrainment of fines) to 100%. An average recovery is used in the **Model** and is shown below.

- Recovery grass to pellets estimate: 83% (***refs: 9, 29, 31, 32***)

Comparison of Fuels

Since the purpose of pelleting agricultural grass is to produce a combustible fuel, it is worthwhile to review the characteristics of various fuels. This gives an overall picture of the relative value of using pellets as compared to the fuels that are currently being used for heat or co-generation.

The main market for pellet fuel at this time is residential space heating. There are currently few domestic pellet furnaces (ie large volume) available. Besides residential uses, pellet space heating is also realistic for small industrial users and for greenhouses and barns (***ref: 33)***

Heat output of fuel is measured in giga joules (GJ). Besides characteristics such as moisture content and ash content, fuels vary in their GJ content. At the time of writing, the current prices of various fuels were compared to their GJ content:

Fuel	**Price ($)**	**$/GJ**
propane	$0.701/litre	$27.46
Heating oil	$0.82 / litre	$ 21.33
Electricity	$0.106 / kwh	$ 29.44
Natural gas	$0.192 / m3	$ 5.18
Coal	$130 / tonne	$ 4.69
Wood residue (wet)	$38 / tonne *	$ 4.31
Wood residue (dry)	$45 / tonne **	$ 2.04
Pellets	$367 / tonne *** $203 / tonne ****	$ 20.39 $ 11.28

* No commodity price for wood residue. Current local prices shown.
** No commodity price for wood residue. Current local prices shown.
*** Average current regional price of wood pellets
**** Current commodity price of industrial grade (high ash) wood pellets (***refs: 34-36***)

It is worth noting that the price paid for round wood delivered to the mills in the Rainy River District (Ainsworth Engineered and Abitibi Bowater) is in the range of $46/tonne. (***ref: 34***)

A fuel price comparison is incorporated into the **BECAPP Model** and can be adjusted with changing fuel prices.

Although this is not the whole picture (no comparison is made here of the efficiencies of various heating “appliances” nor is there any measure of the overall energy balance in producing the fuel), from a market perspective it is necessary that pellets as a fuel appear to ``compete`` with other forms of fuel. For example, it currently makes economic sense to convert from fuel oil heat to pellet heat. As long as natural gas stays within its current price range, it does not make economic sense to convert from natural gas heat to pellet heat.

- Energy content switchgrass pellets is 18.8 GJ/tonne ***(refs: 7, 20, 21, 22)***
- Energy content reed canary grass pellets is 18.5 GJ/tonne (***ref: 9***)

The conversion of grass to pellets requires energy inputs. A review of the studies published on line identified a wide range in the estimated energy inputs, dependant upon whether or not the estimates included anything from drying to bagging. PSI provided an estimate of 0.36 GJ/tonne pellets produced. This is lower than the average values averaged from other studies (0.53 GJ/tonne pellets). The range of values is shown below.

- Energy requirements for pelleting grass: 0.3 GJ to 0.5 GJ/tonne ***(refs: 20, 32, 37)***

Current Market Conditions

The immediate market within the scope of this project would most likely be domestic consumption for space heating using conventional pellet stoves.

To get a picture of the "local" market for pellets, the retailers from Rainy River to Fort Frances to International Falls were contacted (***ref: 36***) One retailer did not wish to disclose its annual sales. The total of the other retailers for 2008 was estimated to be about 450 tonnes of wood pellets. In general, it was noted by the retailers that there is a huge demand for wood pellets not currently being reliably met by suppliers. Pellets came from British Columbia, Manitoba, Ontario and the USA (West Virginia) Supplies have been irregular, one reason being the closure of sawmills reducing or eliminating wood residue feedstocks. Retailers also mentioned highly variable quality of the pellets, between suppliers and within the same shipments from the same supplier. The quality issues noted were ash, smoke, crumbling, fowling of the pellet stove grates and excessively fast burning rates.

The retailers contacted also sold pellet stoves. With the exception of one retailer, who was starting to provide the higher end "close couple gasification" stoves, retailers sold wood pellet stoves exclusively. The reason for this was lower prices (wood pellet stoves retail about $1000 less than the higher end models), and the availability of wood pellets (or lack of availability of other pellet types).

A review of on-line information estimated that an average household would require 3.2 tonnes of pellets per year for heating purposes (***refs: 18, 38, 42)***. A 100,000 tonne/year operation, the maximum considered in this study, could provide pellets for about 30,000 households. Sales of pellets in the Rainy River District in 2008 suggest a local market of about 150 households.

There was a limited market for other pellet products which included horse bedding, pet food and livestock feed (***ref: 36***). It is beyond the scope of this study to review the requirements involved in the pelleting animal feed.

Horse bedding requirements are in the range of about 2.6 tonnes per horse per year (***ref: 1).*** A 100,000 tonne/year operation, the maximum considered in this study, could provide bedding for about 32,000 horses. Pelleted horse bedding is available locally but there were zero sales in 2009. (***ref: 36***).

Abitibi Bowater's co-generation boiler in Fort Frances is another potential market for bio energy fuel crops. Abitibi Bowater is currently doing trials using agricultural grasses with the objective of attaining a target of 15% "agricultural biomass" feedstock. This target could represent a total of 108,000 tonnes per year of agricultural biomass being fed into the boiler in Fort Frances. The boiler is engineered to burn wood residues or "hog" which is generally 50% moisture content (MC). It is not capable of burning dry fuel. One of the company's objectives is burning of high moisture pulp mill sludge (75% MC) in the boiler. This wet fuel can be "sweetened" with a drier fuel, such as agricultural grasses (10-15% MC), bringing it down to the optimal firing range of 50% moisture. (***ref: 39***)

Currently, Abitibi Bowater has made no commitment for the use of agricultural grasses and has not specified a price that would be paid for this feedstock. It is anticipated that the price that will be offered to suppliers of agricultural grasses will be within the range of other suitable (dry) biomass fuels. Current prices being offered for wood residues is shown in the table in the **Comparison of Fuels** section. It is worth noting that Abitibi Bowater has committed to paying $58 per baled tonne of agricultural grasses for its trials but this is not reflective of market value due to additional subsidies being paid to producers involved in these trials. Feeding the boiler with baled grasses has been identified as a problem in the feed system. The issue of clinker formation in the boiler has also been historically noted. There is currently no co-generation firing of wood residues and grass products on a commercial scale in North America (***ref: 39***). In the event that Abitibi Bowater commits to firing of 15% agricultural biomass feedstock in its boiler, and commits to using pelleted biomass feedstock as opposed to baled grass, a best case scenario is that it could get 100% of its targeted volume from a local pellet operation.

Ontario Power Generation (OPG) in Atikokan is another potential market for bio energy fuel crops. OPG put out a Request for Expressions of Interest (REI) in January 2009. (***ref: 40***) The objective of this project was stated as "investigating opportunities for the use of solid biomass fuel" and to run a "test program" for firing bio-fuels along with coal, ostensibly to replace coal by 2014. Fuel specifications were identified in the REI. Of particular concern with respect to grass fuels is the stated maximum ash content of less than 1.5%. Neither switchgrass nor reed canary grass currently meet this specification. It remains to be seen if OPG is interested in using grass (or wood) pellets for co-firing with coal in its power boiler in Atikokan. Other fuels being considered include wood residues, bio diesel, ethanol and round wood ("purpose grown" forest crops).

Europe is currently both the largest producer and consumer of wood pellets in the world. Consumption in 2008 was estimated to be over eight million tons, with Sweden, Denmark, the Netherlands, Belgium and Italy being the largest consumers on the continent. Sweden is the largest producer and consumer of wood pellets in the world with a total domestic demand of 2.1 million tons from both power plants and households. Wood pellets sell in Sweden for $425/tonne, retail value (***ref: 41***)

Retail prices have to be distinguished from commodity prices. At the time of writing, commodity prices for premium grade wood pellets were about $265/tonne (***ref: 18***) Commodity prices for industrial grade wood pellets (greater than 1% ash) were about $203/tonne (***ref: 43***) . There is no specific commodity price for agricultural grass pellets. For the purposes of this study, prices for wood pellets were used in the **Model**. It is assumed that grass pellets, due to their high ash content, would fall into the North American ``industrial`` grade or European ``B``grade.

North American pellet producers are looking at the European market for their pellets. Plans are under way to build a massive plant in Duluth's inner harbour to produce 500,000 tons of wood pellets every year to ship to Europe's power plants The Duluth plant would be built by the Kedco Group of Cork, Ireland, an international renewable-energy company with a specialty in large wood-pellet boilers in Europe and elsewhere. (***ref: 44***) The cost of ocean transport from the Great Lakes Region is estimated to be $35-$50/tonne. (***ref: 13***).

The amount of "competition" from wood pellet producers has to be factored into risk decisions about the economic viability of a grass-based pelleting operation.

- Commodity price for industrial grade pellets estimate: $203/tonne (***ref: 43***)
- Commodity price for premium grade pellets estimate: $265/tonne (***ref: 18***)
- Average local retail price for premium grade wood pellets estimate: $367/tonne (***ref: 36***)

Future Options

Conversion to agricultural bio energy crops involves a level of risk that has to be weighed into the long term commitments required for the capital investment of a pelleting operation.

It was noted earlier that it takes up to 3 years to achieve optimum yields for switchgrass and reed canary grass. A review of the studies published on line identified that for a pellet operation to be economically viable, production rates in the range of 45,000 to 75,000 tonnes per year are required (***ref: 13***). For the range of yields anticipated for the Rainy River District, a low of 6,000 hectares to a high of 20,000 hectares of crop land would have to be converted to bio energy crops to meet the above production range. Capital expenditures for a pellet operation supporting this level of output would be in the $3.5 Million to $6 Million range (***ref: 29, 30***). The **BECAPP Model** looks at a range of possible areas, yields and final volumes.

Market conditions that are **necessary** to support a grass-based pellet industry of the scope envisioned in this feasibility study:

- Abitibi Bowater would have to commit to burning grass pellets, sold at commodity prices, in its boiler
- The majority of domestic pellet heaters would have to be capable of burning grass pellets ("close couple gasification"). These stoves would have to be similar in price to conventional wood pellet stoves.
- The price of grass-based pellets would have to be considerably cheaper than wood pellets to convince consumers to upgrade to the higher end pellet stoves.

- Pellet furnaces, as opposed to pellet space heaters, would have to become available for domestic use.
- The prices of alternate fuels, particularly natural gas, would have to increase.

Market conditions that would **enhance** a grass-based pellet industry:

- Environmental legislation would prohibit the firing of coal for the generation of electricity.
- Local power generation would become attainable through incentives (see the **Funding Sources** section)
- Municipalities would commit to conversion to "green fuels" for heating municipal buildings.
- There would be significant consumer and industrial incentives offered for conversion to "green" fuels.

It is worth noting that there is currently great interest in private sector access wood and wood residues to develop alternate industries as the traditional forest industries flounder. The annual allowable cut in Ontario is 24 million cubic meters (***ref: 45***). In January 2009, the Ministry of Natural Resources issued a "Request for Expressions of Interest" (REI) for wood supply in Ontario. The purpose of this initiative was to bolster new manufacturing opportunities by providing access to crown wood. The total amount of fibre requested as a result of the REI was 45 million cubic meters. (***ref: 46***) An expansion in availability of wood fibre would increase "value-added" forestry options which would also generate more wood residues. Increased wood residues (or roundwood) would enhance the economic viability of wood-based pelleting operations and would be in direct competition with grass-based pelleting operations.

There are a couple of options that would decrease the risk to producers looking to convert to bio energy fuels.

Producers could partner with forest industries such as sawmills and establish pelleting operations that could switch between grass pellets and wood pellets. Discussions with the pellet manufacturers identified that this is simply achieved by switching out of the pelleting dies. Grass and wood fibre must be run separately and cannot be mixed together in the pelleting process (***ref: 15***).

Reed canary grass has been studied for its potential as a forage crop. There are a few select low-alkoloid varieties that are suitable for cattle feed. These are "Palaton", "Rival", "Bellevue", and "Marathon" (***ref: 47).*** It is possible that during a downturn in the pellet market, reed canary grass could be baled and sold for forage.

Long term options for a commercial bio energy agricultural pellet operation might be co-generation for the production of electricity. This would involve burning pellets in a specially designed boiler to generate electricity. The new Green Energy Act is paving the way for small scale energy projects of this nature. However, the required boilers and infrastructure is very expensive. Under current market conditions, it is not economically feasible to generate electricity from grass pellets. (***ref: 16)***

Another long term option for bio energy agricultural corps might be conversion into ethanol. The feasibility of this option is beyond the scope of this study.

A "non-commercial" option is the production of bio energy grasses for personal use by producers. Mobile pelleting equipment could be used in this case, there would be no quality standards to meet, and no bagging or shipping requirements. For producers requiring significant space heating for greenhouses or barns, "home-made" pellets might be an option.

Funding Sources

There is a great deal of interest in "green" fuel in its many forms. A review of the initiatives and funding opportunities indicated a bias towards electricity generation and liquid "biofuels" such as ethanol and bio diesel. The new Green Energy Act will streamline the process that allows small energy producers to connect to the Grid.

Both Canadian and American governments are looking at ways to reduce our dependence on foreign oil by providing funding for liquid fuels.

There are a lot of initiatives for energy conservation, including converting to more fuel efficient appliances.

The Ontario Power Authority's "Standard Offer Program", now replaced by the Feed-in-Tariff Program (FIT program) provides small electricity generating facilities a standard pricing regime of 11.08 cents/kwh for electricity produced from "biomass" ***(ref: 48)*** This equates to $30.78/GJ. Compare this to the other fuels shown in the section **Comparison of Fuels**. While not directly providing an incentive for a pelleting operation, it does provide an incentive to small electricity generating facilities to utilize pellets for fuel.

The following initiatives and funding organizations may be accessible for the establishment of an agricultural grass pellet operation:

- **Ministry of Northern Development and Forestry** (***ref: 49***)
  Emerging Technology program: Northern Ontario Heritage Fund Corp (NOHFC) provides funds for initiatives related to value-added products, biotechnology projects

  Enterprises North Job Creation: NOHFC provides financial assistance to private sector to create new jobs, including capital costs, funding up to $1M.

  Innovation Demonstration Fund: administered by the Ministry of Research and Innovation, support to proponents developing and commercializing new technologies, focuses on pilot-scale technologies, including bio-products and alternative energy. Funding up to $4M per project.

Northern Ontario Grow Bonds Business Loan: assistance to new businesses by investing in capital projects that directly result in permanent full-time employment.

- **National Research Council** (***ref: 50***)
  Research and Technology Development Activities: funding to small and medium enterprises who want to grow using technology to commercialize services, products and processes in Canadian and international markets. Also provides mentoring support and invests on a cost-shared basis for research.

Summary

Running the **BECAPP Model** using the values summarized under each section identified a breakeven price for pellets of $244/tonne at a farm gate price of $134/tonne. This exceeds the range of current commodity prices for industrial grade wood pellets (greater than 1% ash content).

Obviously the objective of a commercial pelleting operation is to make a profit. Pellets have to sell at greater than breakeven prices to achieve a profit. It was noted under the section **Current Market Conditions** that there is no specific commodity price for grass-based pellets. It is assumed that grass-based pellets will sell at industrial grade prices ($203/tonne) but due to their high ash content (7%), it is possible that they will sell for less.

Despite the current interest in pelleting of agricultural grass, there remains some major obstacles in developing this industry.

The high ash content of reed canary grass and switchgrass limits its use in domestic space heating. High ash fuels cannot be burned in standard wood pellet stoves. High ash pellet fuels are classified as “industrial grade” pellets and sell at lower prices than premium grade pellets. Industrial grade grass-based pellets may have a use in co-generation by Abitibi Bowater as a “sweetener” to decrease the overall moisture content of pulp mill hog fuels. From an economic standpoint, it is unlikely that Abitibi Bowater would opt to pay more for grass-based pellets than for commodity priced wood pellets.

Besides ash content, another major obstacle in the commercialization of agricultural bio energy grasses is the fact that this product must “compete” with wood residues from logging and milling operations. Wood residues are a “free” by-product and, as such, tend to be bought and sold at salvage prices.

There are very significant capital and operating costs associated with pellet manufacture. Both capital and operating costs identified in the studies were much lower than those provided directly by the manufacturers. It was noted in **The Pelleting Process** section that there was a huge variation between the quoted operating costs provided by manufacturers. An average value of $71 per tonne was used to determine the breakeven point for profitability. If the higher quoted cost is used ($105/tonne), the breakeven point for profitability would be a commodity pellet price of $278/tonne. A commodity price for grass-based pellets and a more specific estimate for operating costs would have to be established to determine breakeven profitability

Running the **BECAPP Model** using the quoted costs did not reflect any economies of scale. It would be expected that a larger operation with higher inputs and outputs would show an overall improvement in unit costs. This was not apparent in the **Model** and is a shortfall in the calculations of overall profitability. For more precise values, detailed engineering costs would be required from the various manufacturers.

Some improvements in profitability might be realized if the following alterations are made:

- Increased commodity price for pellets. This does not address the issue of ash content. See Scenario 1
- Reduced operating costs. See Scenario 2
- Maximum crop yield has positive effect on pellet plant profits. See Scenario 3
- Reduced capital costs.

Scenario 1: No profits are realized at a farm gate price of $134/tonne baled grass until pellet commodity prices exceed $244/tonne. (See Appendix A, Scenario 1 Chart)

Scenario 2: Pellet plant profits drops as operating prices increase (See Appendix A, Scenario 2 Chart)

Scenario 3: Pellet plant profits increase with increased crop area and increased yield per hectare. (See Appendix A, Scenario 3 Chart)

Reduction in costs may be achieved by purchasing component parts and hiring local contractors for construction. Overall pellet plant uptime could be increased (from 310 days per year). Bulk pellet operations instead of bagging would reduce capital and operating costs. This might be a feasible option if the main market is Abitibi Bowater.

This Phase I feasibility study was undertaken to provide an overall review of the commercial viability of agricultural grass pelleting in the Rainy River District. Although market conditions do not appear to support a pelleting manufacturing facility as envisioned by the BECAPP project members, the evolving "green" fuel economy will likely make a project of this scope and intent more viable in the near future.

K. Smart Engineering is pleased to support the BECAPP project and is available for further engineering studies for this, or other, projects in the Rainy River District.

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APPENDIX A

BECAPP EXCEL MODEL

SCENARIO 1 CHART

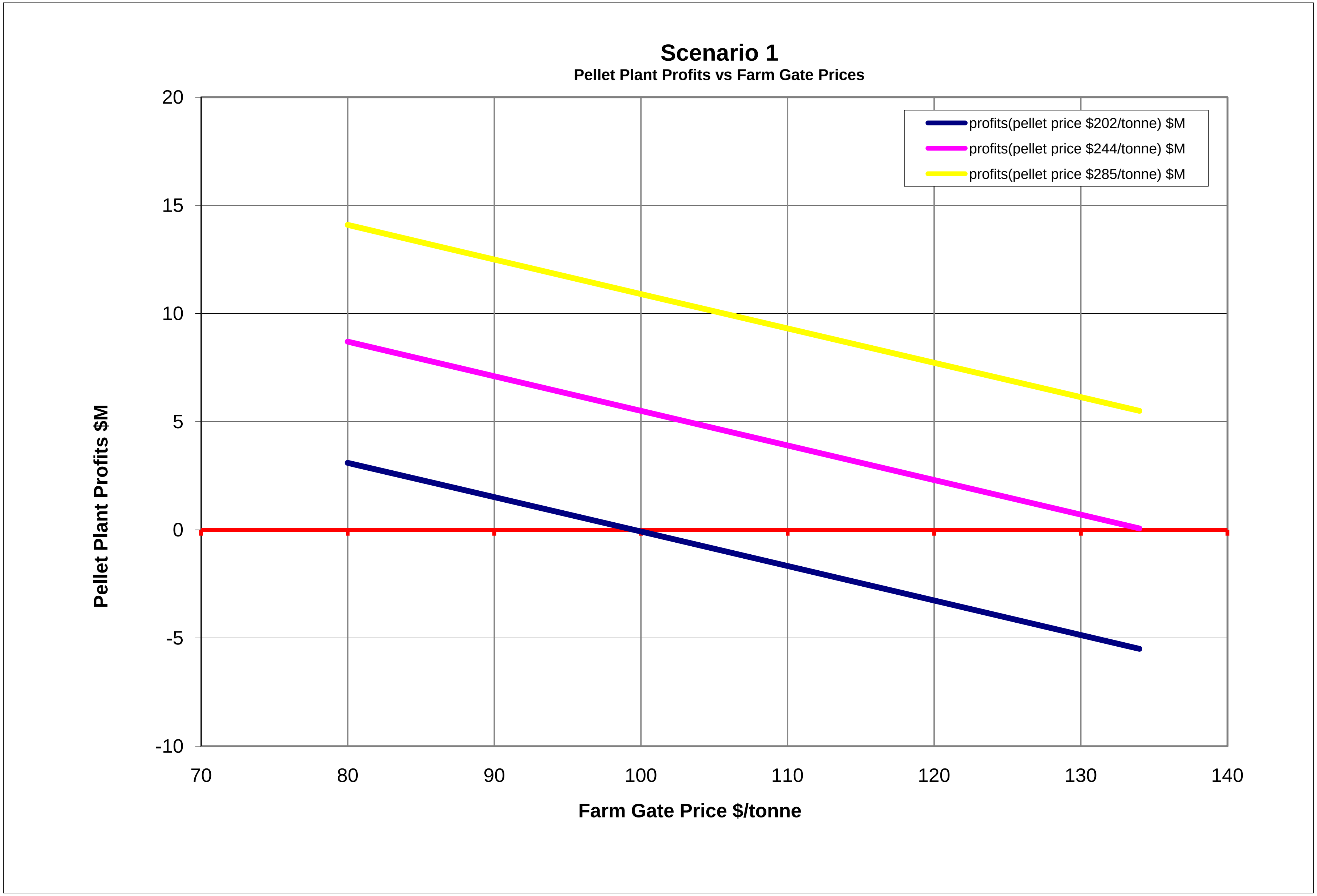
Pellet Plant Profit vs Farm Gate Price

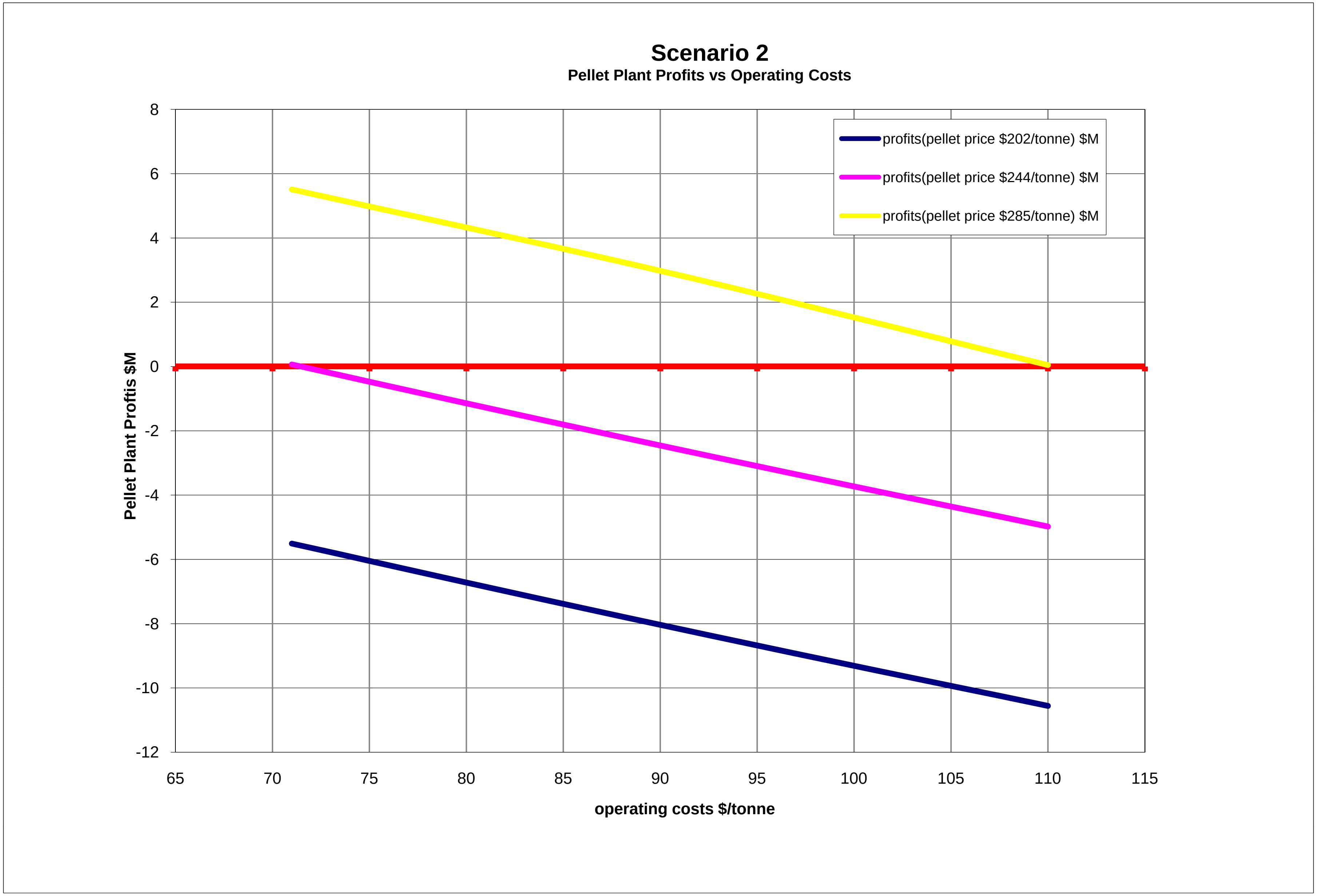
SCENARIO 2 CHART

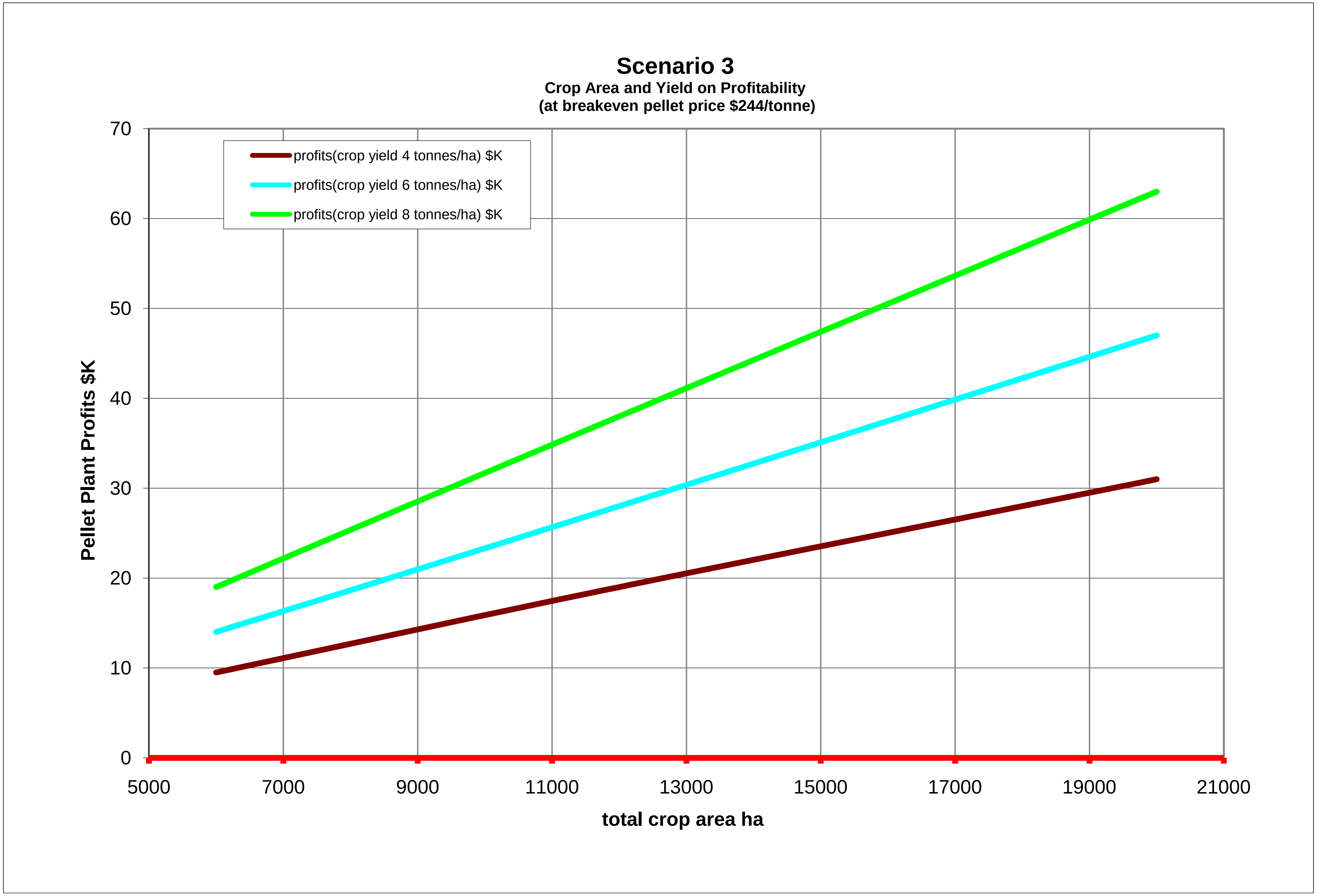
Pellet Plant Profits vs Operating Costs

SCENARIO 3 CHART

Crop Area/Yield vs Pellet Plant Profit


Scenario 1
Pellet Plant Profits vs Farm Gate Prices
profits(pellet price $202/tonne) $M
profits(pellet price $244/tonne) $M
profits(pellet price $285/tonne) $M
Pellet Plant Profits $M
Farm Gate Price $/tonne
20
15
10
5
0
-5
-10
70
80
90
100
110
120
130
140


Scenario 2
Pellet Plant Profits vs Operating Costs
profits(pellet price $202/tonne) $M
profits(pellet price $244/tonne) $M
profits(pellet price $285/tonne) $M
Pellet Plant Profits $M
8
6
4
2
0
-2
-4
-6
-8
-10
-12
65
70
75
80
85
90
95
100
105
110
115
operating costs $/tonne


Scenario 3
Crop Area and Yield on Profitability
(at breakeven pellet price $244/tonne)
profits(crop yield 4 tonnes/ha) $K
profits(crop yield 6 tonnes/ha) $K
profits(crop yield 8 tonnes/ha) $K
Pellet Plant Profits $K
0
10
20
30
40
50
60
70
5000
7000
9000
11000
13000
15000
17000
19000
21000
total crop area ha