AURORA RESEARCH INSTITUTE
AURORA COLLEGE

AGNORTH PROJECT – PHASE 2

OVERVIEW OF ACTIVITIES & PILOT FACILITY DESCRIPTION

INTRODUCTION

During 2012/2013, the AgNorth team completed the first phase of the project which included a market study and technical design work. Several potential scenarios were identified and evaluated. There was enough evidence to suggest that a year-round modular farming business could make economic sense in the NWT.

The Executive Summary from the Phase 1 report is attached in Appendix A. The full report can be obtained online from the Aurora Research Institute (www.nwtresearch.com).

Phase 2 of the project is focusing on stakeholder engagement and implementation planning for a proposed AgNorth pilot facility. In order to move forward with this, partners will need to be identified and commit to working together on the pilot.

The three communities considered most suitable for establishing and operating a pilot facility are Hay River, Fort Smith and Yellowknife.

PHASE 2 ACTIVITIES / SCHEDULE

The key activities being carried out during Phase 2 (i.e. from October 2013 to March 2014) are as follows:

Research and Engagement (October & November 2013)

- 20 to 25 introductory meetings with potential partners, customers and interested stakeholders to gauge interest in the AgNorth concept and gather feedback;
- Additional research into technical areas (such as power supply, building envelope considerations, HVAC considerations, etc.) to identify potential implementation issues, solutions and cost implications (capital and operating);
- Completion of a scan of relevant northern greenhouse initiatives and technology applications to provide additional context for the objectives, benefits and challenges associated with the AgNorth concept.

Stakeholder Workshop #1 (tentatively planned for December 11th or 12th, 2013)

- The purpose of the workshop is to bring together all interested parties to discuss the AgNorth concept, review the latest information and determine if there is sufficient interest to proceed with implementation planning for a Pilot Facility;
- The location of the workshop has yet to be determined but is expected to occur either in Hay River, Fort Smith or Yellowknife.

Pilot Facility Implementation Planning (January to March 2014)

- Assuming the results of the December workshop are positive (i.e. sufficient partners interested in moving forward), the AgNorth team will work in collaboration with its confirmed partners to undertake detailed planning and design work for an AgNorth pilot facility. A contract will be issued to COMDEV and/or University of Guelph to help support this work. Depending on circumstances, this work may include bringing the northern partners to the UofG to see the prototype work underway there;
- It is hoped that the planning and design work can be advanced far enough to accurately estimate the capital and operating budgets required for the Pilot project. Time and budget-permitting, this information will be used to begin drafting funding proposals for Phase 3 of the project.

Technology Refinements and Development (Ongoing)

- In parallel with the NWT-specific work described above, members of the AgNorth team at COMDEV and the University of Guelph's Controlled Environment Systems Research Facility (CESRF) will be continuing with ongoing research and development work, including the deployment of a module to Kuwait and following up with Ontario stakeholders expressing interest in a pilot project in northern Ontario. This work (being funded by others) will help advance the technology and reduce technology-related risks, all of which is a direct (and free) benefit for the AgNorth project and NWT residents in general.

AGNORTH PILOT FACILITY OVERVIEW

The general purpose for building and operating a Pilot Facility is to verify the expected technical and economic performance of the AgNorth concept and provide customers with an opportunity to gauge the quality of the produce grown.

Objectives

Following are the suggested Objectives for the Pilot Facility (these are subject to change based on stakeholder feedback):

- To confirm the building requirements, layout and specifications needed to support a viable AgNorth operation;
- To gather operational data to enable additional refinements to be made in critical systems such as the CO^2, humidity, LED lighting, nutrients etc. to ensure optimal growing conditions can be established and maintained;
- To confirm the expected horticultural performance (i.e. output, quality, taste);
- To obtain operational experience to help determine an optimal scale of operations (or range of options) for a commercial facility;

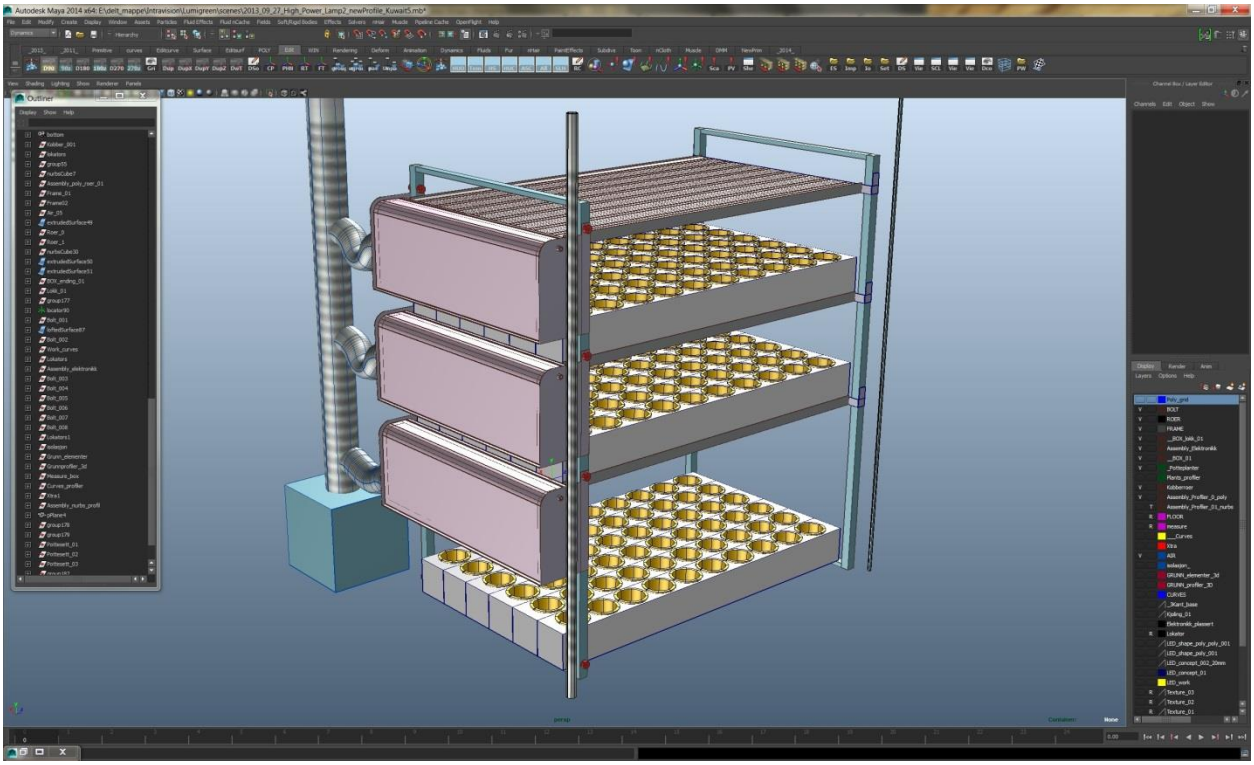
- To confirm customer interest in longer-term produce supply arrangements and determine the specific crops and wholesale pricing that could form the basis for a commercial facility;
- To determine an appropriate organizational structure (for the northern partners) and develop sufficient capacity to support Phase 3 of the project; and,
- To determine the estimated capital and operating budgets required for Phase 3 and initiate development of funding proposals.

Physical Description

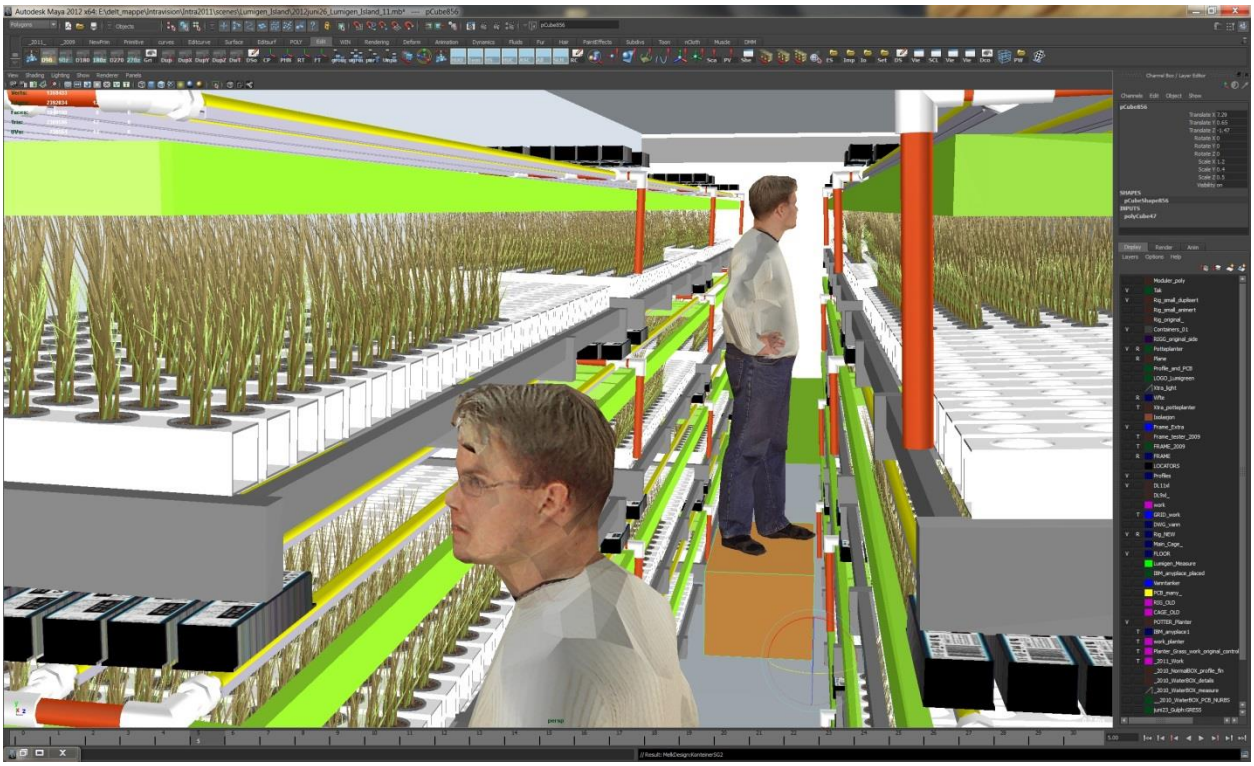
To obtain the optimal growth rate and productivity in a crop, a farmer would prefer to control several environmental factors including temperature, atmospheric conditions, nutrient composition and lighting spectrum and intensity. Research has shown that optimizing these variables in a controlled environment system can double, or in some cases, even triple standard greenhouse productivity.

The AgNorth concept involves the use of growing modules which would measure about two metres in length, 1.2 metres in width and 2 metres high. Each module would have 3 or 4 levels for crop production, depending on the type of crop. Modules would be placed together in benches which can be organized in two basic configurations. The estimated output for each module is 1,000 kg of produce per year (will vary somewhat depending on the crop grown).

A diagram of the AgNorth growing module is shown below:



An illustration of how the modules could be arranged in benches within a controlled environment growing area is shown below:

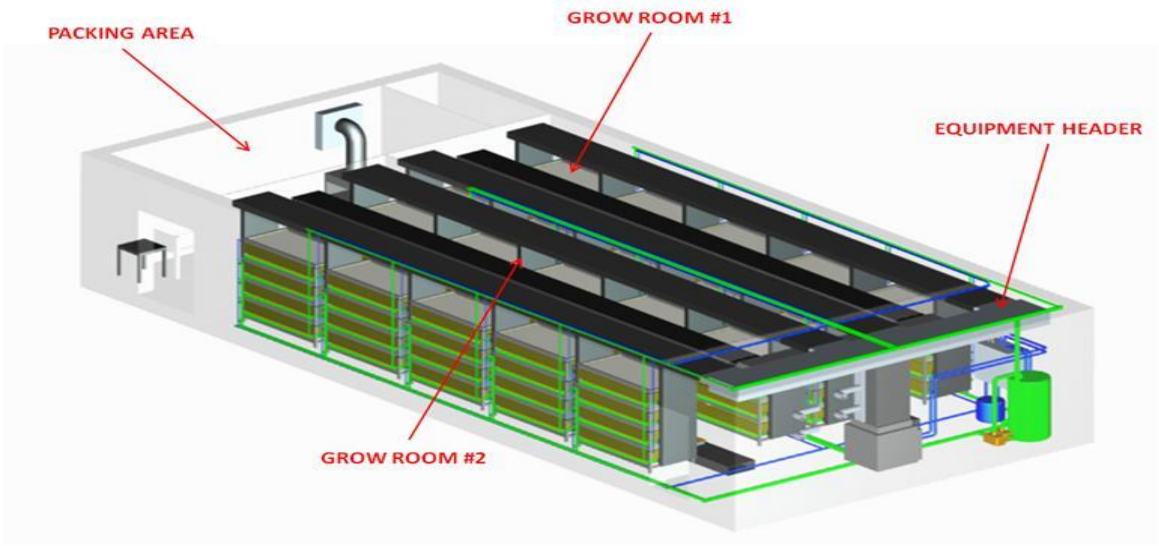


For the Pilot Facility, the AgNorth team is considering the deployment of 10 to 20 growing modules that would be organized in 2 benches. The total footprint of the Pilot Facility is expected to be about 1,200 to 1,500 sq. ft.

The growing area would be contained within an insulated “box” which would be constructed from panels. Depending on the number of modules placed within the box, the peak power load is estimated at 60 – 100 kW.

The most suitable location to conduct the pilot phase is likely an unused warehouse. Additional investigation is underway to determine how to best integrate the growing area “box” with a building’s existing electrical, HVAC and plumbing systems.

The diagram below provides an example of how the operation might be set up within an existing building or warehouse:

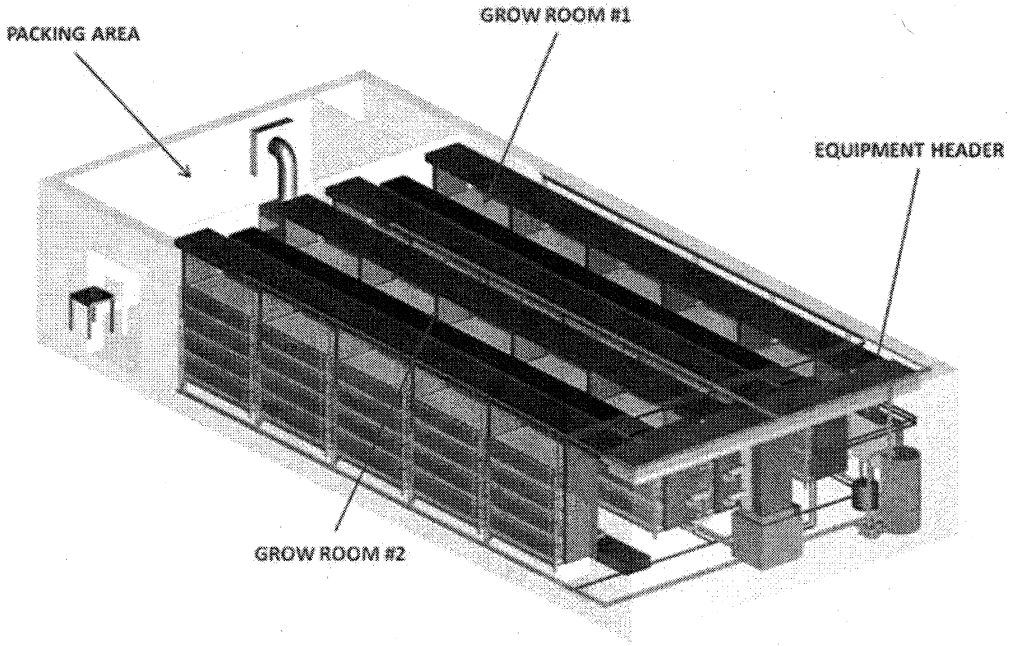


Further refinement of the layout and design of the Pilot Facility is anticipated to occur in the January – March 2014 time period in collaboration with northern partners and based on a selected site.

Phase I

AgNorth Modular Farm Concept

Technical Design and Market Study



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EXECUTIVE SUMMARY

Food security in Canada's north has been identified by all levels of government, and the public at large, as a challenge that needs to be addressed. Fresh produce consumed in the Northwest Territories (NWT) comes from farms as far south as Columbia in the winter months, taking an average of 10 days to make it from the field to Yellowknife, where it is then further distributed around the territory. These distances and travel times significantly inflate costs and reduce quality of produce in NWT communities.

Compounded with the lack of access to quality produce is the fact that aboriginal populations in the NWT have decreased their consumption of traditional food and increased reliance on store-bought foods that tend to be nutrient-poor and energy-rich. Access to quality produce could help improve diet and reduce the prevalence of diet-related chronic diseases such as type II diabetes, heart and circulatory disorders and cancers.

AgNorth is a scalable, modular farm system, that uses highly efficient light emitting diode (LED) lighting and hydroponics technologies to grow high-value, nutritious fruit and vegetable crops. The concept of a modular food production system is based on technology transfer from an ongoing research program in advanced life support systems led by COM DEV Canada and the University of Guelph in collaboration with the Canadian Space Agency and NSERC.

The purpose of this report is to evaluate whether AgNorth is a feasible option for growing nutritious fruits and vegetables to address the NWT's food security needs.

A review of available academic and market information suggests that, per-capita, NWT residents purchase between 130 and 190 kg of fresh fruits and vegetables annually, depending on their location, availability of produce, income level and retail price levels. This is somewhat lower than the Canadian per-capita average consumption of about 213 kg. For the entire NWT, it is estimated that about 8.0 million kg of fresh produce is sold each year, with an estimated retail market value of about $17.0 million (in current dollars). Most of the produce consumed in the NWT is shipped in from Canadian, American and Mexican farms.

Most of the technologies used in the AgNorth modular farm are identical to those commonly used in Canada's conventional greenhouse industry. The exception is the use of high efficiency computer-controlled LED arrays that allow the operator to grow food year round in a high density multi-layer facility.

Key inputs associated with an AgNorth modular farm facility include:

- a source of uncontaminated irrigation/cleaning water that must be free of pathogens;
- a source of soluble mineral nutrients, acid, and base;
- a source of CO_2 for enhanced growth efficiency (liquid CO_2 preferred);
- a source of reliable electrical power;
- a source of seeds;
- a source of packaging materials; and,
- a source of organic growth media or rockwool (as determined by crop requirements)

Key outputs from an AgNorth modular farm facility would include:

- packaged produce (fruits and vegetables);
- plant inedible biomass (could be used for high quality organic compost);

- 'grey' waste water from cleaning and irrigation; and,
- recovered heat energy from the lights available for redistribution.

The first step in assessing the productivity and economic viability of the AgNorth concept, was to identify nutritious, high-value crops that could be grown efficiently in a multi-tiered growing facility, were commonly consumed throughout the NWT and are being imported to the NWT from foreign markets. Commodities that satisfied these conditions included romaine and other leaf lettuces, red and green peppers, cherry tomatoes, spinach, green onions, strawberries and leafy herbs (e.g., cilantro, basil).

A productivity model was produced to estimate the operating costs required to produce various commodities. A number of different options were considered as well as forecasted improvements in high efficiency LED technology. Key findings from the modeling work indicated that the size of the facility, the specific crops grown, and the cost of power were all significant drivers in determining the total cost of operating an AgNorth facility.

While the cost of production is obviously a critical factor in determining where an AgNorth facility might be located, an equally important consideration is the location and needs of the customers that would potentially purchase fresh produce from an AgNorth facility. Potential wholesale customers for AgNorth produce include Northern Stores (with 18 retail stores in the NWT), the Yellowknife Co-op (the other 7 Arctic Co-op stores in the NWT are served directly by air from Edmonton), Northern Food Services (which supplies hotels, restaurants, caterers, schools, health care facilities, stores etc.) and Bouwa Whee Catering (which serves mine sites) – all of which operate from Yellowknife.

Several different scenarios were examined to develop a better understanding of how factors such as the scale of operation, the location of the facility (i.e. community) and the ability to access / serve key customers might impact on the economic viability of the AgNorth concept.

The first scenario (Yellowknife A) examined the possibility of setting up an AgNorth facility in Yellowknife. The advantages included easy access to many wholesale produce customers and access to key inputs. The facility was sized to 40% of the wholesale market for 5 crops: cherry tomatoes, romaine lettuce, red peppers, herbs and strawberries. This would generate annual produce sales of approximately $1.0 million. The specific building requirements needed (envelope, airtightness, power etc.) and the systems needed were used to derive an estimated capital budget of about $9.3 million to construct the facility. An annual operating budget was estimated to be $956,000. Of this, power costs (65%) and labour costs (17%) were the two largest expense items.

Given the high cost of power, a second Yellowknife scenario (Yellowknife B) was examined in which a conventional greenhouse is added to the AgNorth facility to allow for sunshine to replace the use of LED lights for at least 6 months of the year. This hybrid option would add at least $1.0 million to the capital budget but would reduce the estimated annual operating costs by about $200,000 / year due to reduced power consumption. Several potential options were noted that could help improve the economic viability of the AgNorth concept, however, further discussions with other stakeholders and further investigations will be needed to assess these options.

The next scenario that was investigated involved the establishment of a smaller AgNorth facility, located in either Fort Smith or Hay River, to serve the South Slave region. The idea was to determine whether the economic viability might improve with access to cheaper power rates (compared to Yellowknife), even though the scale of operation would be reduced. For analytical purposes, it was assumed that a regional facility would serve about 8,000 people which would result in annual produce sales revenue of $500,000. At this scale of operation, the annual operating costs for a facility located in Hay River were

estimated to be about $615,000, which would result in an operating loss. Locating the regional facility in Fort Smith, where power is cheaper would result in breakeven scenario. While this has not yet been discussed with the power utilities, negotiation for an agricultural power rate in this region could result in profits of $100,000 per year.

From a technical perspective, the AgNorth system is modular in design and can be scaled up or down to fit a particular market. While a very small growing facility could technically be established to serve a single community, the project team found that the operational and economic realities made it an unlikely option at this time. The technical complexity of the facility requires access to skilled tradespeople and an experienced horticulturalist, which are not typically available, on demand, in the smaller communities. In addition, the high power demand would cause problems on an isolated diesel-electric grid and be prohibitively expensive at diesel power rates.

Overall, the Yellowknife and regional scenarios were considered worthy of further investigation and refinement. For either scenario, it is clear that additional revenues, either from retail produce sales and/or sales of by-products (excess heat, organic waste materials), and access to cheaper power are the two main avenues to pursue to potentially improve the economic viability of the AgNorth concept.

The last section of the report outlines the technical tasks necessary to move this technology forward in an economically feasible way. A key activity in this regard is the development of a prototype AgNorth facility at the University of Guelph, currently underway, which will improve performance and reduce technical risks. Lessons learned will be incorporated in the design of a NWT pilot project.

In terms of next steps, the AgNorth team have, through its work on this phase of the project, identified a number of potential northern stakeholders and partners that may be interested in participating in the development of a pilot AgNorth facility and eventually a commercial enterprise. While the technical work proceeds at the University of Guelph, the AgNorth team is proposing to hold engagement meetings with stakeholders (i.e. local growers, wholesalers, aboriginal governments and businesses, utilities, alternative energy suppliers, government agencies etc.) to present the findings in this report and explore possibilities. Once a critical mass of potential partners has been realized, a stakeholder workshop, to be held in Yellowknife, is proposed to build a vision for the AgNorth pilot project.

The AgNorth team has developed a set of objectives for an AgNorth pilot project that would grow a single crop to satisfy the consumption needs of about 3500 people. The facility would have a footprint of 24 x 57 foot, requiring 60 kW and could be completed within a $2.0 million capital budget.