Request for Proposals: Management Solution for Sustainable Rotational Grazing

September 29, 2021

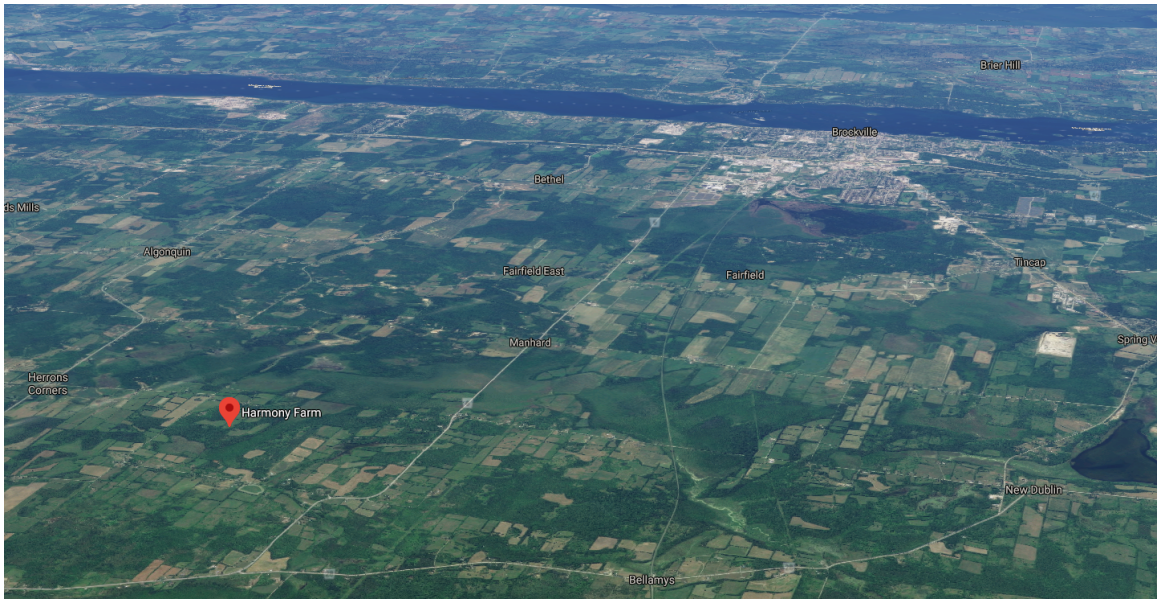

Figure 1: Harmony Farm, just outside of Brockville, ON. From [1].

1 Abstract

This Request for Proposals seeks to frame the opportunity for a solution to several current problems surrounding the implementation rotational grazing, a sustainable farming practice, at Harmony Farm, a small-scale farm in Brockville, Ontario.

Rotational grazing is the practice of constraining livestock (pigs in the case of Harmony Farm) to a sub-section of a larger field. This allows for the livestock to intensively graze one portion of the pasture before they are transferred to the next subdivision. Rotational grazing is contrasted by the conventional grazing technique, where the livestock is allowed to free range the entire pasture. Rotational grazing has multiple intended consequences: first, it reduces or eliminates the need for commercial feeds for the livestock; second, it uses the grazing livestock to till the field, thereby avoiding the use of tillers; and third, it uses the livestock's manure as fertilizers, improving soil quality and eliminating the need for artificial fertilizers. Greg Huntington, the owner and operator of Harmony Farm, anticipates many challenges as he plans on implementing rotational grazing for the first time this season. These challenges arise from the need to frequently relocate the interior fences, livestock, and their shelter.

An effective solution to this problem will benefit several parties: Greg, who can use the design to make his farm more sustainable, attractive to consumers, and save costs; consumers seeking to buy organic and cheap products would benefit from the successful implementation of Greg's farming technique; livestock, with whom this solution closely interacts; and other small-scale farmers who also plan on implementing rotational grazing and face similar problems.

In accordance with stakeholder values, this opportunity's core objectives are sustainability, safety, and feasibility of implementation. A solution must address at least one of the outlined issues and, where applicable, needs to be effective in containing, caring for, and moving the livestock between pasture subdivisions, easy and affordable to implement and use, minimize environmental impact, and be safe for the operator and the livestock.

Current solutions, which do not integrate the aforementioned components, fail to adequately meet the requirements laid out in this RFP. Greg currently uses ordinary speedwire electric fencing which tangles easily (therefore not easy to move) and is sensitive to grounding by plants or snow. He plans on building a plywood shelter on wooden skis, which could be dragged by a tractor. However, this is a time-consuming project with questionable feasibility, as it risks damaging the field and causing quick wear to the shelter. Furthermore, Greg does not currently have a solution to move the pigs. Other existing solutions to Greg's problems, such as chicken wire, pre-built shelters, and livestock trailers are too costly, difficult to use, or do not meet requirements for safety and implementation.

As a result of these factors, there is an opportunity to design either one or a set of solutions, depending on the scale of the design and the schedule of Praxis II, to make rotational grazing at Harmony Farm more sustainable, safe, and cost effective.

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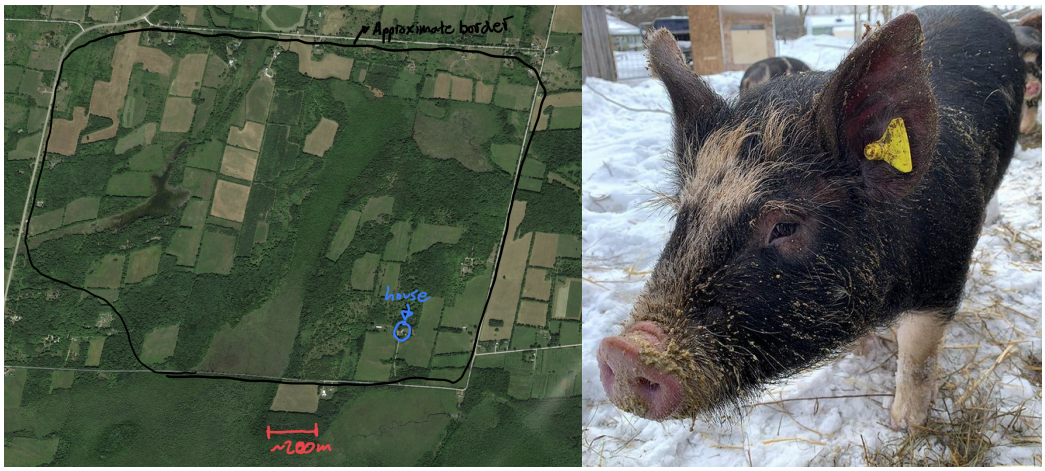
2 Overview of Community and Opportunity



(a) An aerial view of Harmony Farm. From [1].

(b) One of the pigs that will be grazing the pastures of Harmony Farm. From [2].

Figure 2: Harmony Farm

We, a team of first-year student engineers, contacted Greg, a sustainable farmer in Brockville, Ontario, who has owned and operated Harmony Farm (Figure 2(a)) since early 2020. In initial meetings with Greg, he discussed a new technique he plans to implement, rotational grazing. This process, one of multiple manifestations of sustainable farming, seeks to fertilize soil for crops by using livestock (shown in Figure 2(b)) to intensively graze small sections of a field at a time, removing weeds, feeding the livestock, and fertilizing the land with manure.

The purpose of this RFP is to outline the requirements and current dogma surrounding a solution to contain and move the livestock to effectively practice rotational grazing. The proposed solution should adhere to sustainable practices, be safe for both the farmer and livestock, and be easy to implement.

3 Technical Background

3.1 Sustainable Farming

Sustainable farming is a method of farming that is composed of three pillars: economic profitability, environmental stewardship, and social responsibility [3]. This means maximizing profit while maintaining the environmental health of the farm as well as improving the quality of life of the people involved with the farm. Each farm is affected by many uncontrolled, distinct factors; therefore, farmers have no unified solution to practicing sustainable farming. Instead, there are several guidelines and techniques that farmers can follow to increase the sustainability of their farms.

Economic profitability is the difference between the costs of running a farm and the revenue it brings. There are a number of ways to increase this difference without sacrificing

environmental and human health. For example, growing a greater variety of crops provides protection against fluctuations in market demand and improves the quality of local water sources [3]. This stabilizes the profit margin and benefits the farm's environment.

Environmental stewardship involves certain practices that preserve or sometimes even enhance the farm's ecological health. Practices such as crop rotation and minimizing industrial tilling can decrease the effects of soil erosion and increase profitability [4]. Crop rotation involves planting different crops at the same location over time. Some crops have increased yield when planted in the rubble of other crops [5]. Tilling is used to prepare the soil for seed germination and root growth [6]. However, tilling also leaves the soil vulnerable to soil erosion. Minimal tillage systems involve tilling the soil just enough to optimize it for crop production as well as protect it from soil erosion. This can also save on fuel costs due to reduced machinery operation.

Social responsibility refers to the quality of life of everyone involved in a business, a sustainable farm in this case [3]. This can range from the employees on the farm to its consumers. Ensuring fair treatment of workers and maintaining communication with consumers is vital to running a sustainable farm.

3.1.1 Regenerative Farming

Regenerative Farming relates to the environmental stewardship aspect of sustainable agriculture. It involves techniques and practices that can reverse climate change by rebuilding and restoring the soil [What is Regenerative Agriculture?]. Some practices include minimum/no till systems, crop rotations, application of compost and animal manures, and grazing practices. Applying compost and animal manure increases the soil's fertility and restores its microbiome [7]. Alternatives such as artificial fertilizers tend to create imbalances in the soil's microbiome resulting in weaker crops and causing climate change [7]. Grazing practices such as rotational grazing can improve plant growth and overall land productivity. This has a positive effect on both the animals and crops involved.

3.1.2 Rotational Grazing

Rotational Grazing consists of practices that contain and move animals throughout subdivisions of a pasture so that they graze on one sub-region of the pasture at a time. This allows the rest of the pasture to rest, letting the plants grow again with deeper root systems [8]. With deeper roots, the soil becomes more compact and thus more likely to resist erosion. Rotational grazing also has many other environmental and economic benefits which will be further discussed as it closely ties to our community of focus, Harmony Farm. Special accommodations must be made when implementing rotational grazing, namely a method to contain the grazing livestock to certain regions of the pasture and a method to efficiently relocate the animals.

4 Team Positionality and Biases

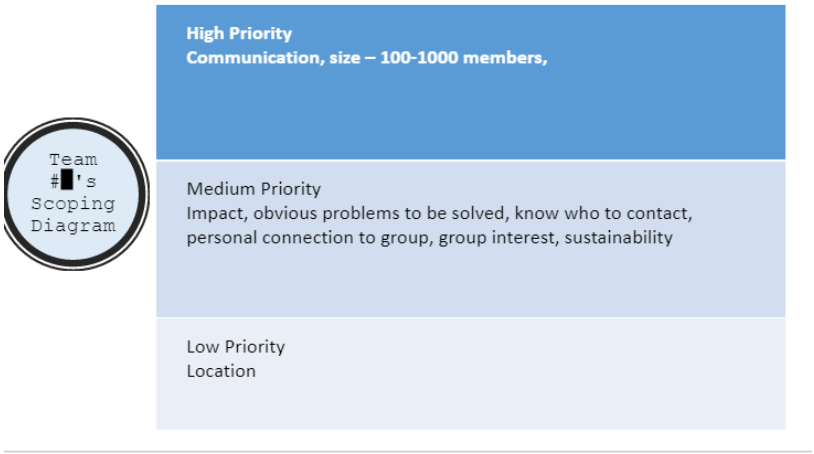


Figure 3: The teams scoping diagram, written before we reached out to communities.

The team values, some of which outlined in Figure 3, that we set in preliminary team meetings affected our team's decision on which community with which to engage. One important team value is timely communication. We all agreed on the importance of responding quickly to address others' concerns and planning meetings ahead of time because everyone has many other commitments on top of this design project. By extension, we also prefer a community that responds quickly and is more available, so we would have less trouble scheduling meetings. Timely communication would also lead to a productive relationship, which was something else we valued. For example, when we have a confusion regarding some details of our community, we can immediately contact someone relevant and expect a timely response instead of continuing the project with assumptions and uncertainties. Finally, members of our team have a shared passion for nature, especially sustainability. This influenced which communities we prioritized in contacting.

With these values in mind, we felt it would be advantageous to leverage any personal connections when seeking a community for two reasons. First, we would likely have more prior knowledge on the community and their values, so the engagement process would be more efficient. Second, the stakeholders would be more willing to engage, once again resulting in a more productive relationship. Before we contacted Greg and his Harmony Farm, we had some basic understanding of his personal values as well as the farm's goals due to a personal connection between Greg and one team member. We even conducted some prior research, especially in regenerative agriculture, before meeting Greg. This led us to prepare a series of questions more catered towards his values, which effectively resulted in an efficient communication process.

We acknowledge that our values led to biases in multiple stages of interacting with a community. First, they heavily influenced which community with which we chose to engage. This was the intended affect of these values - to serve as guidance in our community selection process. After we decide to work with a community, however, we must prioritize stakeholder values instead of our own. For example, we kept in mind that sustainability is a

team value, but it may or may not be the priority of Greg and his Harmony Farm. Dwelling on sustainability would also limit the opportunities we create, as any community, especially Harmony Farm, is multi-dimensional. During our first meeting with Greg, we made sure to focus on multiple aspects of his farm instead of merely sustainability, such as his fiscal goals, management situation, and ongoing projects like building a greenhouse. We made sure especially to not lead our stakeholder to make statements related to sustainable farming to fit our agenda, as this would be dishonest and detrimental to truly understanding the community. Finally, personal connections can lead to biases towards the community, particularly the focus on the positive attributes of the farm. This could cause anchoring when generating opportunities. To minimize the detrimental effects of our biases, we conducted ample research to ensure our views are accurate and not based on our initial assumptions.

In addition to leveraging the personal connection with Greg, we decided to work with Harmony Farm because Greg is passionate about interacting with our team to provide information regarding his farm. Moreover, Harmony Farm operates on the principle of sustainable farming, which aligns with our team's values. We felt that having this shared value would lead to more interest from both parties, and thus a more productive relationship.

5 Harmony Farm and Greg's Rotational Grazing Plans this Farming Season

Figure 4: Harmony Farm

Greg is a sustainable regenerative farmer who manages an animal and plant farm, Harmony Farm, in Brockville, Ontario. The farm consists of 200 acres of fields, pastures, forest, and creeks. He had lived in cities his entire life until, in early 2020, he moved with his family to Harmony Farm and began farming full-time. Harmony Farm produces meat and organic vegetables while also growing crops to feed the alpacas, goats, chickens, pigs, and ducks of the farm. Greg manages all aspects of his farm, from preparing fields for crops to delivering the farm's products to customers. One of the focuses of Harmony Farm is sustainable farming [9]. This objective is achieved through using less machinery, less pesticides, and keeping

soil rejuvenated for future crop growth. This year, Greg plans on adopting the rotational grazing technique for the first time. In short, rotational grazing the practice of subdividing a pasture into many small regions and restrict the livestock to intensively graze one region for a set period before rotating to the next region. Greg has both short-term and long-term goals in mind for this practice. He expects rotational grazing to immediately reduce his reliance on commercial feeds. In fact, rotational grazing will lead to faster grass growth since intensively grazed and manured fields grow faster than average [8]. Greg's long-term goals include to rejuvenate the soil of this four-acre field, so it could be used for crop growth within a few years, eliminate the need for chemical fertilizers by using pig manure instead, and keep practicing this grazing technique to increase biomass and decrease the use fossil fuel machines, thus helping the greater cause of global sustainability. Our team verified, with independent research, the feasibility of Greg's goals.

5.1 Visual Depiction of the Opportunity

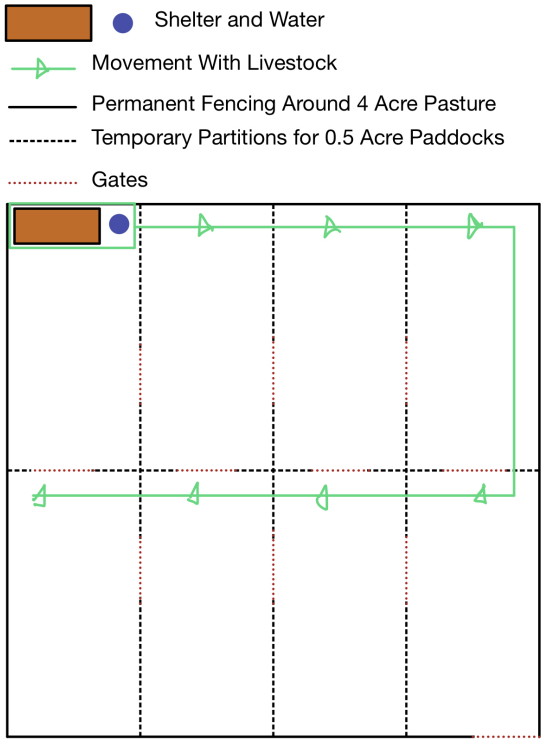


Figure 5: Greg's current fencing plan.

5.2 Challenges that arise from Rotational Grazing

Greg anticipates many challenges as he plans on implementing rotational grazing for the first time this spring. After learning about the details of his plans, we realized that rotational grazing is far from a trivial project. In fact, the implementation of rotational grazing creates many opportunities that could be solved by creative engineering design.

First, the grazing livestock needs to be contained in one of eight half-acre subdivisions of the pasture, which is four acres. As shown in Figure 5, Greg plans on employing two types of fencing: permanent perimeter fencing that surrounds the four-acre field, and movable fencing that should contain the pigs to one subdivision of the field. Currently, Greg plans on using electric page wire for the perimeter fencing. He will place a speedwire along one of the long axes of the perimeter which will be used to power high tensile steel wires that he plans on using to subdivide the pasture. However, Greg acknowledges that electric fencing is not the ideal fencing solution, as it does not work reliably and it cannot be easily moved when a new pasture needs to be grazed. It is also quite costly, as the fencing itself costs $3000 per kilometre. The electric energizers will cost another few hundred dollars. Second, the grazing livestock needs to be moved from one subdivision to the next which could pose a challenge since, as Greg said, "it's almost impossible to move an animal three times my weight against its will". Greg currently uses food to entice the pigs. Over long distances, however, he would need to transport the pigs using a vehicle. A more efficient means of moving the pigs is significant since Greg must frequently transport them to a different subdivision: he anticipates a frequency of between four days and two weeks when practicing rotational grazing. Thus the second component of a solution is designing a method to efficiently move around 25 to 50 pigs from pasture to pasture. Finally, another issue arises from designing a shelter for the pigs. The shelter should also be easily movable and effectively protect the pigs from rain and sunburn.

Clearly, rotational grazing is complex task and its challenges are multi-dimensional. It may not be feasible to address all problems that Greg encounters. However, creating a meaningful solution for one of the problems within two months is realistic for a small group of first-year student engineers.

5.3 Stakeholders

5.3.1 Harmony Farm

Greg and his Harmony Farm are the primary stakeholders of this Request for Proposal. Greg is looking to benefit from creative Praxis II students' engineering design so he can effectively perform rotational grazing on a four-acre pasture. Greg needs a solution that is cheap, easy to install, and facilitates all aspects of rotational grazing, notably containing and moving the livestock.

5.3.2 Consumers of Eastern Ontario who are Looking to buy Fresh Produce

Harmony Farm sells its products to residents of Brockville as well as the greater Ottawa-Gatineau region [9]. Among other factors, consumers' decision on where to purchase their fresh produce will depend on the practices of the farm producing it. In general, consumers would prefer purchasing products from local, organic farms [10]. Price is also an important factor. Therefore, a solution that is environmentally friendly and cost-effective would be preferred by consumers. Greg also plans on growing crops on the rotational grazing field after the soil is rejuvenated by this practice. This would directly have an impact on the products produced by the farm, and hence affect the consumers.

5.3.3 Livestock

Figure 6: Baby pigs born in Harmony Farm that will be used as grazers. From [11].

The grazing livestock, which will be pigs (Figure 6), on the four-acre pasture will be affected by our design. The method of moving the pigs should be safe for the pigs and do no physical and psychological damage. Also, the fencing solution should not harm the pigs should they make contact with the fence.

The herding solution should be low stress for the pigs. This would ensure their efficient movement.

The pigs also require a shelter that is effective in sheltering them from rain and providing shade during hot, sunny days.

5.3.4 Other Sustainable Farms

The need for a more efficient rotational grazing technique is a common theme in many small scale farms, not just Harmony Farm. Other farms could therefore also benefit from our engineering design. If the solutions we create are successfully implemented in Harmony Farm, these designs could be, with minimal modifications, applied to other small-scale farms who are employing rotational grazing. However, teams' primary focus shall be designing a viable opportunity for Harmony Farm.

5.3.5 The Environment

The environment is directly impacted by the solutions we employ. The fencing we use and moving options both could have implications on the environment. Moreover, Greg had emphasized over multiple occasions that environmental sustainability is significant in his plan to rotationally graze his fields. The environment would benefit from recyclable fencing materials [12], [8].

5.4 Connection between the Stakeholders

An effective solution will have different effects on the different stakeholders. However, they will all benefit from such design. Moreover, the stakeholders are intricately linked. The livestock is a part of Harmony Farm, so the latter shares many objectives with the former. The primary stakeholder, Harmony Farm, is related to the consumers because the latter's decision on where to purchase farm products depends on the cost and the practices of the farm, both of which may be affected by the solution. The implications of a better grazing solution could be significant for other farms that also practice rotational grazing. Although the livestock does not care about the efficiency or price of the solution, they require a solution that is safe. This is also a top priority of Greg and Harmony Farm as their practices must be in line with OSPCA [13], and they would not want permanent harm on the pigs.

A well-designed solution would directly impact Harmony Farm, but it could also have an effect on other farm practicing rotational grazing. This is because Greg's problems are not specific to his farm, but, as he mentioned in our third meeting, common to many of the farmers he knows.

6 Requirements

6.1 Core Objectives

The primary objective of this opportunity is to develop a solution to the problems associated with rotational grazing of the four-acre field on Harmony Farm. The solution should take into consideration the needs and values of the stakeholders, particularly Greg, the grazing livestock, and the environment.

6.1.1 Sustainability

As per the stakeholders goals, the team values, and the extensive research proving the benefits of sustainable farming ([4]), sustainability, both in the production and use of the solution, is a central component of a successful design.

6.1.2 Safety

Keeping the stakeholders safe is essential for a usable design. Several standards for safety of farm equipment, like [14], exist for ensuring safety of farmers, and [15] details requirements for animal welfare.

6.1.3 Feasibility of Implementation

There are two aspects - ease of implementation and cost of implementation. Greg has indicated the lack of free time when working at a farm. He usually works more than 12 hours per day. He says in our second meeting, "from 6 in the morning to well after dark," and, "this is the only job that I start the day with a to-do list, and by the end of the day, the list gets longer than when the day started." Clearly, a solution that is quick to learn and implement is ideal. For the same reason, the solution should also require minimal attention during the grazing season. Lastly, the solution should be affordable to Greg, who is operating on a limited budget. One of his objectives not related to the rotational grazing project is to not lose money running Harmony Farm.

6.2 The Requirements Model

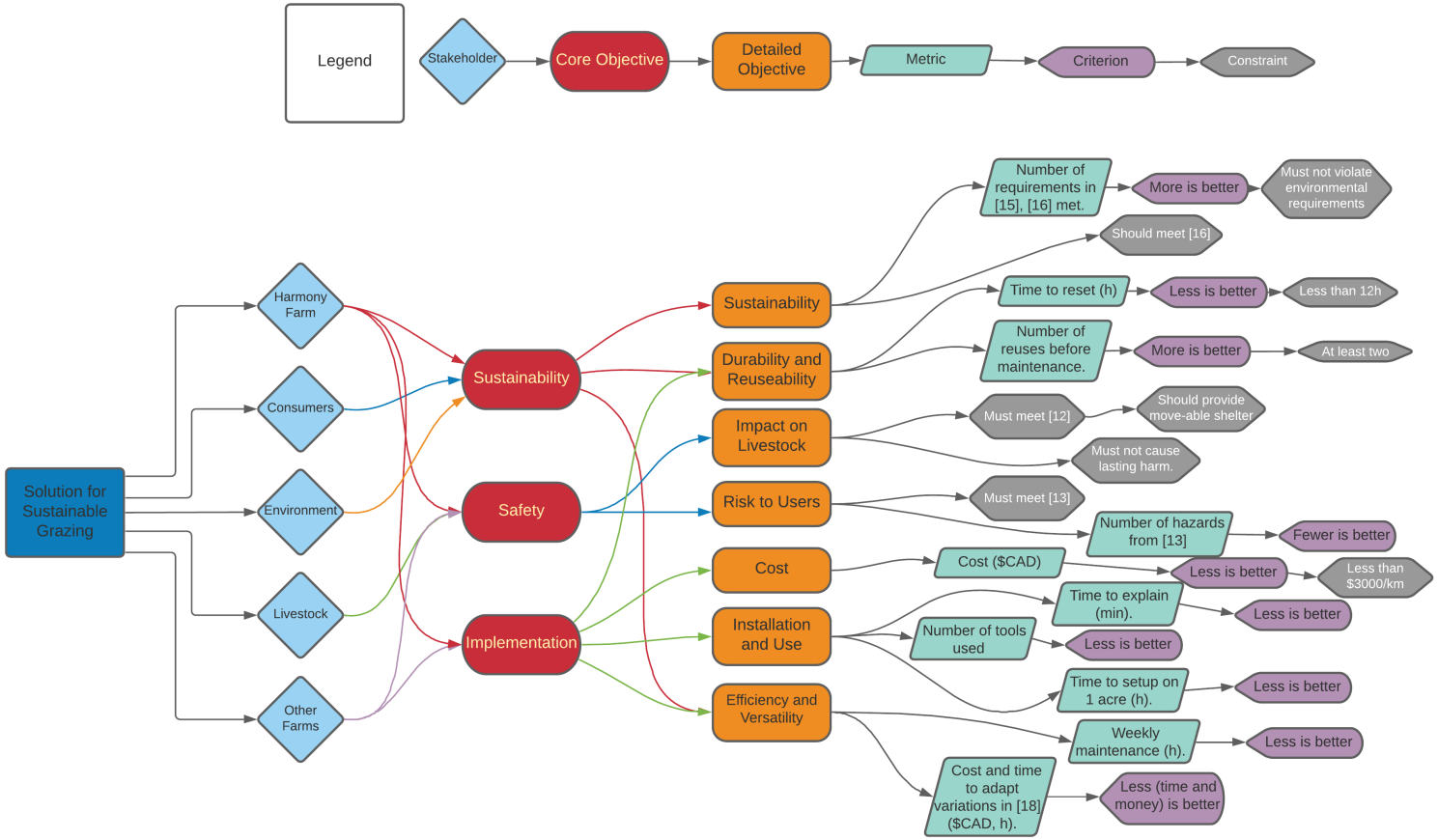


Figure 7: The requirements model and its interconnections.

6.3 Detailed Model

6.3.1 Sustainability

Description The solution should minimize environmental impact and enable sustainable farming practices.
Metric(s) The solution should facilitate sustainable farming of both crops and livestock. Solution should meet the requirements for farming and the environment from the Rainforest Alliance's *2020 Sustainable Agriculture Standard: Farm Requirements* [16], as seen in Appendix: Standards.
Criteria More requirements within [16] and [17] met is better.
Constraints Must not violate core requirements in section 6 of [16], *Environment*. Proposal should meet consideration for sustainable livestock management as per [17].
Justification Sustainability is a core belief of both Harmony Farm and the team. It is also key to slowing climate change, a major objective of the environment stakeholder [12]. Also, the target market of Harmony Farm is Earth-conscious consumers, so sustainability is marketable and has economic implications. To be implemented in the community, the solution must meet the requirements of regenerative agriculture, as outlined above.

Durability and Reusability

Description The solution should be reusable with minimal manual intervention before reuse.
Metric(s) 1. Time to reset before reuse (hours). (As tested on a 10m x 10m proxy) 2. Number of reuses before maintenance is needed. (Estimated based on components used)
Criteria As specified by Greg, less time to reset the system before reuse in a different pasture is preferred. More reuses before replacement of components (for example fencing, posts, batteries, etc.) is better.
Constraints Solution must be usable at least twice before full or partial replacement in order to outperform existing electric fencing solutions and be more sustainable. Design must not require more than a full working day (12 hours) to reset.
Justification Another tenant of sustainability is reusablility. A successful design should be usable several times before needing to be replaced, and should not require too much time to reuse due to the busy nature of a farm.

6.3.2 Safety

The solution should be safe for the operator and livestock.

Impact on Livestock

Description The solution should care for the livestock which are grazing the fields by including water and shelter, ensuring sufficient food, as well as not harming the animals.
Constraints Solution must ensure at least minimum care as per the *Ontario Society for the Prevention of Cruelty to Animals (OSPCA) Act*, [13], [15] (Appendix: Standards). As outlined in the act, the fencing solution "must be in a state of good repair" and must be "of a texture and design that will not bruise, cut or otherwise injure the animal". The shelter must provide adequate resting space for 25 pigs and provide shade and coolness during hot days. The shelter and water source must be movable or accessible by the pigs in throughout the rotational grazing practice. Finally, the solution for relocating the pigs must attempt to minimize any stress caused by the moving [18].
Justification To adhere to Ontario Law and stakeholder values, namely the pigs of Harmony Farm, the grazing solution should be safe and provide for the livestock contained by it.

Risk to Operator

Description To protect the farmer, in this case Greg, and be a viable product to be used by other farmers, the fencing solution and method for pig relocation must be safe for the operator.
Metric(s) Number of hazards as outlined in [14], an excerpt of which is in Appendix: Standards, the ISO Agricultural Machinery General Safety Requirements.
Criteria Fewer hazards is better.
Constraints Must adhere to [14]. Must be effective in preventing pigs from escaping as free-roaming pigs can cause havoc and harm to the farm.
Justification A solution that is dangerous to operate will not be implemented to protect the operator.

6.3.3 Implementation

The primary stakeholder has limited time and money, so an effective solution should be accessible by being (1) quick to set up, and (2) affordable by a small-scale farmer operating on a limited budget.

Cost

Description The solution should be affordable.
Metric(s) Cost ($CAD)
Criteria Cheaper is better.
Constraints The fencing solution must not cost more than the current inadequate solution at $3000/km.
Justification In order to be implemented, the solution must be within the budget of Harmony Farm.

Installation and Use

Description The solution should be easy to understand, install and use for a farm owner with some experience in fencing.
Metric(s) 1. Time to explain solution with enough detail for the solution to be independently setup by the listener (minutes); alternatively, time to assimilate to written instructions for the user to feel confident in successfully setting up the solution (minutes). 2. Time to setup the fencing solution on a half-acre field (hours). If no field of this size is available, a 10-metre by 10-metre proxy should be used. This should then be used to approximate the time needed to set up the solution on a one-acre field. 3. Number of tools required to install one section of the fencing solution.
Criteria Less time or tools required for each metric is preferred.
Justification In line with the primary stakeholder's circumstances; time is limited on a farm so an easy-to-use system is crucial.

Efficiency and Versatility

Description The solution should be quick to set up, as well as require little maintenance after being setup.
Metric(s) 1. Time required to maintain the solution per week (hours). 2. Time and cost required to modify the solution for a change in crops, grazing livestock, or field size (or other modifications as discussed in [19]) (hours and $CAD).
Criteria Less maintenance is preferred. The less time and money to adapt solution, the better. The current solution does not cost money to move, so the new on should cost as little as possible.
Justification The solution must not only be cost effective initially, but remain within budget in the long-term. It must also be adaptable to the changing conditions and needs on the farm with as little extra work required as possible, once again since time is in such short supply at Harmony Farm.

7 Reference Designs

As mentioned before, no all-in-one solutions or procedures of implementing rotational grazing exist, so this section is broken down into several components that a complete solution should include. However, once again, depending on the work required to design the proposed solution and the Praxis II course schedule, one component of the solution may be sufficient. One should also note that the following examples should only give designers a general sense of existing, imperfect solutions. This may aid the designer to generate new solutions that better satisfy the outlined objectives. Being anchored by these designs would be unproductive and deviate from the intended purposes behind their inclusion.

7.1 Containment

- **Electric Fencing**

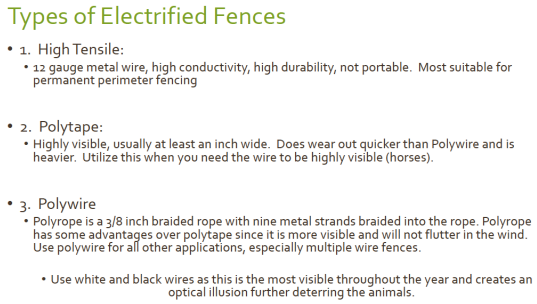


Figure 8: Types of electric fencing. From [19].

There are different types of electric fences. They all consist of some sort of metal strip that can carry a current and can be respooled and rolled out to contain livestock in various parts of the pasture. The type that Greg currently uses costs $3000/km and is the reference for the cost objective.

Advantages	**Disadvantages**
Can be respooled so has multiple uses	Long time to set up (multiple days)
Designed to be safe for humans and livestock: humans only feel a mild shock upon contact	Long time needed to respool and reapply for different partitions
	Can be grounded and rendered useless if nearby plants touch the wire
	Can be trampled by livestock and they may get caught in it

- **Chicken Wire**

Figure 9: Chicken wire fencing. From [20].

Chicken wire is a very cheap type of fencing which consists of woven metal wire.

Advantages	**Disadvantages**
Very cheap	Not strong enough to withstand large livestock like pigs (thus dangerous)
Very quick to install	single use; cannot be moved without tangling the fencing
	sharp wires may cut livestock.

- **Permanent Wood Fencing**

Figure 10: Permanent wood fencing with integrated electric wire. From [21].

This is the type of fencing that Greg plans to use as a perimeter for the 4 acre section to be grazed. Greg will include electric fencing "hotwire" as shown in Figure 10 to power the electric fence partitions.

Advantages	Disadvantages
Very durable, does not require much maintenance or repair	Very costly, Greg says upwards of $6000/km
Uses physical strength to contain livestock which does not cause harm compared to shock-based containment	Not movable/versatile
Made of wood, a sustainable material that Greg can source from the many acres of forests on Harmony Farm	Take a very long time to install and requires costly special equipment.

7.2 Relocation

Currently, Greg does not have an engineered solution to move animals. Often, he is able to lure the pigs with food, but he says sometimes they do not respond and he instead has to load them into a trailer and drive them the short distance to the pasture. Other times, the pigs, which weigh upwards of 500 pounds, choose not to cooperate at all so Greg moves on and tries again at another time.

This current method is not adequate as it violates the contain livestock constraint in the Risk to Operator requirement. Greg must get in the enclosure with the pigs and manhandle them into the right place, which is quite dangerous [22]. Also, this can require many hours to do if the pigs are uncooperative, hence not satisfying the requirement for an efficient implementation.

In our research, there were no solutions to move animals tailored to small distances across fences as is required by rotational grazing. Greg mentioned in our third meeting that pigs are hesitant to cross electric fencing even if it lowered and deactivated for fear of being shocked.

7.3 Shelter

The pigs at Harmony Farm currently live in a plywood and beam shack that Greg built. This protects them from various weather conditions and gives them a place to huddle together and sleep. For use in rotational grazing, Greg plans to build a new shelter on wooden ”skis” that can move between pastures with the pigs by being pulled by a tractor. This solution is effective, but dragging the shelter causes damage to the field and excessive wear on the shelter. An ideal shelter would move easily, be large enough to contain the 25-50 pigs, and be durable enough to withstand the rough treatment when moving.

8 Appendices

8.1 Stakeholder Contact

Greg Huntington: *Owner/Operator of Harmony Farm*
Email: farmingharmony@gmail.com
Website: harmonyfarm.ca

8.2 Standards

Rainforest Alliance Sustainability Standard

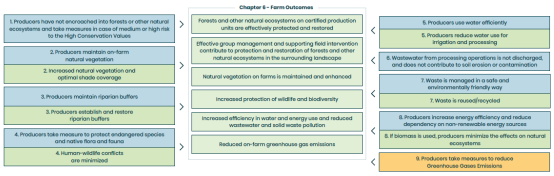
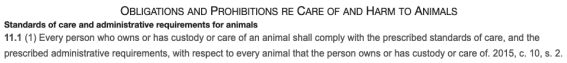


Figure 11: Environmental requirements and farm outcomes. From [16].

OSPCA Act Animal Care Standards



OBLIGATIONS AND PROHIBITIONS RE CARE OF AND HARM TO ANIMALS

Standards of care and administrative requirements for animals

11.1 (1) Every person who owns or has custody or care of an animal shall comply with the prescribed standards of care, and the prescribed administrative requirements, with respect to every animal that the person owns or has custody or care of. 2015, c. 10, s. 2.

Figure 12: Basic requirements for animal welfare must be met. From [15].

ISO4254: Table A.1 Hazards

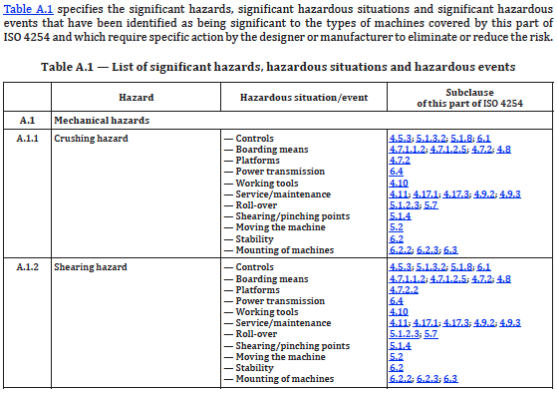


Table A.1 specifies the significant hazards, significant hazardous situations and significant hazardous events that have been identified as being significant to the types of machines covered by this part of ISO 4254 and which require specific action by the designer or manufacturer to eliminate or reduce the risk.

Table A.1 — List of significant hazards, hazardous situations and hazardous events

	Hazard	Hazardous situation/event	Subclause of this part of ISO 4254
A.1	Mechanical hazards		
A.1.1	Crushing hazard	— Controls — Boarding means — Platforms — Power transmission — Working tools — Service/maintenance — Roll-over — Shearing/pinching points — Moving the machine — Stability — Mounting of machines	4.5.3; 5.1.3.2; 5.1.8; 6.1 4.7.1.1.2; 4.7.1.2.5; 4.7.2; 4.8 4.7.2 6.4 4.10 4.11; 4.17.1; 4.17.3; 4.9.2; 4.9.3 5.1.2.3; 5.7 5.1.4 5.2 6.2 6.2.2; 6.2.3; 6.3
A.1.2	Shearing hazard	— Controls — Boarding means — Platforms — Power transmission — Working tools — Service/maintenance — Roll-over — Shearing/pinching points — Moving the machine — Stability — Mounting of machines	4.5.3; 5.1.3.2; 5.1.8; 6.1 4.7.1.1.2; 4.7.1.2.5; 4.7.2; 4.8 4.7.2.2 6.4 4.10 4.11; 4.17.1; 4.17.3; 4.9.2; 4.9.3 5.1.2.3; 5.7 5.1.4 5.2 6.2 6.2.2; 6.2.3; 6.3

Figure 13: A small portion of the table of common hazards from [14].

8.3 Primary Sources

8.3.1 Meeting 1

I tell Greg about the project/potential for future teams, he seems enthusiastic about working with us. Greg does small scale sustainable farming. Sustainable farmers disagree with "Big Ag" and try to promote sustainability, making their farms lower yield but more space efficient. Other sustainable farmers try to use few materials/equipment, Greg likes equipment, but is limited by cost

Rotational grazing: Greg uses his goats to make fields healthier before planting, plans to plant livestock food crops to feed his animals. Field is setup in a grid with one box fenced at a time, animals are free to graze on this section, adding nutrients and removing weeds, they are then rotated to another section. Fencing is an issue in rational grazing since its needs to be moved frequently, currently Greg uses electric fencing but it has many shortfalls: does not work in the winter since snow insulates the animals, does not work if a plant touches the fence (it grounds the circuit), gets tangled when removed (essentially single use), requires batteries when used in a distant field. His current plan: use permanent wood fencing on the perimeter and use electric to partition sections, this way less electric fencing needed. He is not very satisfied with this plan due to his gripes with electric fencing.

Animals: goats, alpacas, chickens, pigs, ducks Pigs are fenced with electric fencing but it is not effective, when Greg feeds them, the pigs rush through the fence and tackle him.

Another problem is with removing rocks from fields before planting, Greg has not found any affordable engineered solutions since the rocks vary from boulders to pebbles, currently he goes through the field and removes them by hand.

8.3.2 Meeting 2

The farm: 19 piglets 22 total sow- female pig, boar - male "farming is learning every day" no fencing, problems with pigs

typical day: "no typical day" - installing/improving infrastructure -maintenance -supplies/materials -husbandry -clean animal spaces

Summer: -crops (planting, seeding, weeding, marketing, harvesting, online store)

"this is my retirement and its the hardest I've ever worked"

minimal environmental impact

everything has multiple purposes "everything is interconnected"

not common, most farming is industrial "bigger is better"

monocroping/cash cropping

-feed local population

"first feed family, then got to market"

3 acres intensive vegetable, farmers market vegetables

sweet corn, flowers, greenhouses (30x150ft) - year round

60acres of hay

20+ years since hay production - animals + machines to rejuvenate

100 acres of wood, tapping trees for maple

not relying on one operation

How much do you make/expect to make?

after established:

Jean fortin market gardener ($100000+/year) market gardening, regenerative farming, industrial

harmony is combination of those

Employees?

1 part time employee, requested government assistance for students, looking for one full time

Other aspects of farming: farming + business, farm stuff + accounting

wake up eat 6, back in after dark 12+hrs

"what you'd hear at the farm today is chainsaws and wood splitters

doing it all

greenhouse in april, fields in may

grazing: any animals (mostly pigs)

4 acres (/60)- perimeter of permanent fence into 10 sections

animals need to be concentrated

migrational grazing at kalahari desert

frost seeding

most knowledge form books/trial and error - FDCR

8.3.3 Meeting 3

current cost: (theoretical, not yet implemented) electric $3000/km (4 acre field is 0.5 km border + extra for partitions) price is just for fence (+$1000 for controller)

ideal fencing solution (high tensile/paigewire): $6000/km

price to move: a lot of fence gets tangled and is thrown out

now greg uses "speedwire" - much easier to use/respool

to move pigs: posts/insulators needed (fairly inexpensive)

electric fences run off of deep cycle solar powered batteries

pigs can overgraze - ruins soil (causes weeds)

plans to keep eye on pigs and move based on current conditions

plans to use 0.5 acre paddocks with 25-50 pigs, moving every 4days-2weeks

livestock should not be rotated back to original pasture for at least 28 days (parasite cycle)

hog (male pig) is kept separate 2-3 sections ahead of herd

shelter + water needs to move with the pigs

takes a few minutes to move herd between sections using food

current problem:

300lb pigs can jump 4ft high over fencing to get food

hog (stripe) 500lbs got out of pen and went into nearby provincial park

winter: shelter from wind/snow/rain/wet

summer: shelter for shade

shelter needs to move with the pigs (drag by tractor)

sloped roof 3ft high at front, 2ft at back. big enough for all pigs squished together 8x12 ft, made of plywood

long term: plan to grow crops in field (food crops for pigs) after 2yrs of grazing

grazing:
reduce reliance on commercial feed (pigs eat grass)
fertilizes field
increases biomass - sequesters carbon
email: farmingharmony@gmail.com