LFS 350:
LET'S AGROECOLOGY FINAL REPORT

University of British Columbia

Group 4:

Introduction

Our community partner, LET'S, is a technology-based international charitable organization that works to provide affordable access to educational, financial, and medical resources, by establishing simple Wi-Fi servers called "Takhti." The aim of our project is to provide information on agroecological practices for integrated pest management (IPM), which can help farmers reduce their dependency on synthetic pesticides. LET'S will incorporate our information into their "Takhti" server system, granting farmers in the Punjab region of Pakistan access to it.

The Punjab region of Pakistan, which is the focus of our project, is a fertile province along the Indian border and the Himalayan Mountains with a population of 93.7 million. The Punjab region's agricultural sector represents about 24% of its GDP. About 75.5% of all the wheat and 70.2% of all the rice in Pakistan is produced in this region. Additionally, they produce an assortment of other crops including cotton, sugarcane and maize; they also grow fruits and vegetables including mangoes, guava, citrus fruits, eggplants, spinach, and sweet potatoes (Jamali *et al*., 2015).

Significance

Based on the most recent statistics from 2015, the agricultural crop lands in the Punjab region of Pakistan are heavily sprayed with pesticides. Currently, there are 17680 thousand hectares of utilized agricultural crop lands in Punjab, Pakistan (Bureau of Statistics, 2015). The amount of pesticides applied to these crop lands is equivalent to 22856 thousand hectares, which means that the amount of pesticides being sprayed on the current agricultural crop lands exceeds the total available area by 29% (Bureau of Statistics, 2015). Acknowledging that our group lacks direct contact with communities in the Punjab region of Pakistan, we will focus on empowering these communities for greater food justice, primarily through researching and providing information on agroecological solutions for IPM. Food justice is a "transformation of the current food system, including but not limited to eliminating disparities and inequities (Gottlieb and Joshi, 2010: ix)," and where communities exercise "their right to grow, sell, and eat healthy food. Healthy food is fresh, nutritious, affordable, culturally-appropriate, and grown locally with care

for the well-being of the land, its workers, and animals (Just Food, 2016)." Our project will concentrate on food justice, by prioritizing the farm workers' right to a healthy and safe work environment, and the communities' "right to…eat healthy food," through reducing the usage of synthetic pesticides and therefore, diminishing their hazardous effects on the health of Punjabi farmers and communities (Just Food, 2016).

A case study of 318 cotton farmers in the Punjab region illustrates that the farmers have a high dependence on synthetic pesticides for pest control as the farmers believed that pests could be strictly controlled by using pesticides. The study documents pest management malpractice in the Punjab region such as spraying pesticides under inappropriate weather conditions, which puts the farmers at an increased risk of exposure to synthetic pesticides. The study highlights the health hazards that farmers face in growing crops, where farmers experience adverse symptoms including irritation of skin and eyes, headache, and dizziness, when they use Organophosphate and Carbamate insecticides (Khan *et al*., 2015b).

Another case study conducted on the use of Organophosphate pesticide (OPP) residues on okra and brinjal crops, in the outskirts of large Punjab cities, found that the OPPs residues in these crops exceeded the European Union's maximum residual levels for OPPs, and that they were "unfit for human consumption" and dangerous to human health (Randhawa *et al*., 2016). Syed *et al*. (2014) also illustrate that the residues of pesticides, such as Chlorpyrifos, on domestically consumed fruits and vegetables in Pakistan far exceeded the limits for these contaminants, based on Food and Agriculture Organization's guidelines for pesticide use. The study elucidates that the long-term consumption of pesticide residues on produce will have adverse health effects on the domestic consumers (Syed *et al*., 2014).

Research looking directly at the long-term implementation of IPM programs within Pakistan's agricultural sector are scarce. Concurrently, the existing studies on promoting IPM practices among farmers in Pakistan focus on the production of cash crops, primarily cotton crops due to the fact that 80% of all pesticides in Pakistan are used on cotton crops (Khan *et al.,* 2015b). As a result, programmes such as the *National Integrated Pest Management Programme* (Nat-IPM) launched, from 2001 to 2004, to reduce pesticides on cotton crops by empowering Pakistani farmer communities through education and training on IPM practices for cotton

production. The agricultural extensions services provided by Nat-IPM to 432 farmers was effective in that several years after the programme ran, farmers were still implementing the knowledge and training acquired from the programme (Siddiqui *et al.*, 2012). The study by Siddiqui *et al.* (2012) elucidate, however, that if agricultural training and education is not provided continuously to farmers and farming communities, they are unlikely to receive information from farmers who participated in the programme. Moreover, by providing information on IPM practices, via "Takhti", our research can potentially help bridge the aforementioned disconnect by ensuring that all farmers can have equal access to information on IPM practices, without relying on others to pass along information.

Although the mentioned case studies are not indicative of all food injustices that communities and farmers in the Punjab region confront, it is evident, however, that there are some farmers and domestic consumers in Punjab who face food injustice, with respect to the care and well-being of workers and the eating of healthy foods. As a result, it is important for our project to provide an alternative possibility for IPM practices that depart from the use of synthetic pesticides, without coercion to Punjabi communities, while promoting universal access to IPM information that empowers farmers to potentially choose "agro-eco-friendly" farming practices (Siddiqui *et al.,*2012).

Objectives

For our community project, our group's objectives focused primarily on providing information to Punjab farmers on agroecological solutions for IPM practices, which reduce the exposure of farmers and communities to synthetic pesticides and increase environmental sustainability. At the same time, an underlying priority for providing agroecological practices to Punjabi farmers and communities will be integrating culturally-appropriate farming practices and local farming knowledge into our prescribed IPM practices.

Our group will explore the following questions for our project with LET'S:

- What are the major subsistence crops in Punjab, Pakistan?
- What are the current pesticide practices involving the major subsistence crops?

- What IPM practices have been developed in Pakistan, or in similar climate regions for the selected crops that can be implemented?
- What management practice can Punjab farmers implement that is sustainable?
- What management practice can Punjab farmers implement that is culturally-appropriate?

Methods

Data was collected through peer-reviewed literature sources to help inform us on the pest problems facing the crops, which our group has selected to focus on, in the Punjab region. It will also be used to identify pesticides being implemented on these crops. Additionally, grey literature such as government agricultural data, non-governmental organization data, and any additional information applicable to our research will be used. Lastly, our group will create a compilation of all our collected research data.

Following the data collection, our group will analyze, through an assessment framework (Table 1), whether or not our collected data is relevant to our community partner, and Punjabi farmers and communities.

Table 1:

Evaluated Components	**Evaluation Question(s)**	**Does our prescribed pest management practice meet the purpose of the evaluated question? (Yes/No)**	**Justification for meeting, or not meeting the purpose of the evaluated question. (Why, or why not?)**
Sustainability	Is our prescribed IPM practices more sustainable compared to the current method being practiced in Punjab region?		

Accessibility	Are all the equipment and ingredients needed for prescribed pest management practice easily accessible to the subsistence farmer?		
The effects on human health	Does our prescribed pest management practice negatively affect the human health?		
Culture	Is our prescribed pest management practice culturally-appropriate?		

This method of analysis will allow us to disseminate and ensure our gathered information is appropriate and useful to our community partner, LET'S. With the consolidated information, we will create profiles for each crop with their associated pest(s), and then provide our recommendations (Figure 1).

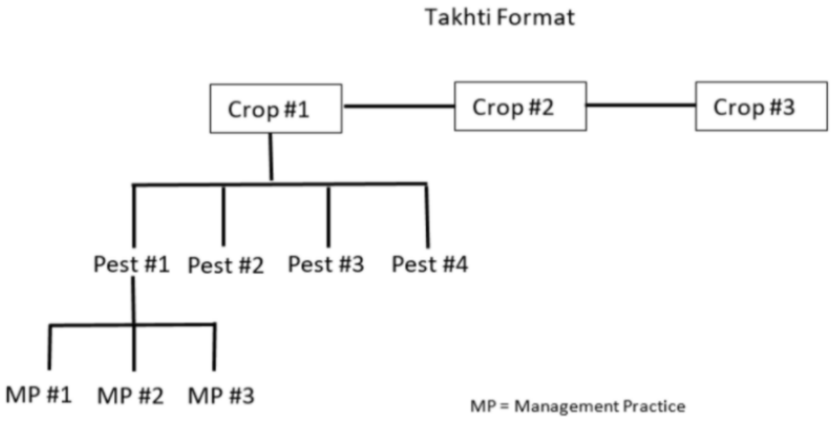

Figure 1. The final formatting of our data and information, which will be presented to LET'S.

Ethical Considerations

Our agroecological recommendations are directed towards helping Punjabi farmers and communities. We will not, however, be directly communicating with them. Therefore, we believe there will be no issues associated with breaking any ethical boundaries, all our recommendations based on literature review will be researched through a culturally-appropriate lens. The only individual we will be contacting and interviewing is our community partner, LET'S, who we will interview using the TCP2 methods for conducting "ethically" sound research.

Results

The following tables show our results and our assessments of several recommended management practices based on our research, focusing on wheat and lentil crops (Tables 3 to 8). Table 2 provides background information on the impacts and symptoms of the selected wheat and lentil crop pests.

Table 2. The impact of the 6 pests on wheat and lentil pests and their symptoms.

	Impact on crops	Symptoms
Wheat rusts	● Wheat rusts cause approximately 3.48% of global wheat yield loss yearly (Bockus et al., 2001). ● Normal yield losses to rust infections are often between 10-70%, depending on the susceptibility of the cultivar, the weather, earliness of infection and many other factors, which has caused hundreds of millions of dollars' worth of damage every year across the globe (Afzal et al., 2008).	● A fungus that forms yellow-orange pustules on the surfaces of leaves, and stems (Government of Western Australia, 2016). ● Severe infections can lead to spores forming inside the wheat grains (Government of Western Australia, 2016). ● There are many forms of rusts that infect wheats. They are, however, all fungi that operate in a similar way. (Government of Western Australia, 2016)

Karnal bunt	● In the Punjab region of India, which borders the Punjab region in Pakistan, scientists found as much as 93% of fields were infected with Karnal bunt (Joshi et al., 1983). ● Overall total yield losses due to Karnal bunt our low (about 10% or less). The contamination of flour with infected endosperms, however, can ruin a batch of flour and cause greater yield loss than is initially seen in the crop fields (Joshi et al., 1983).	● Another fungus that can decimate wheat, the main symptoms are broken hollow grains, dark clumps of spores in the grains, and a strong fishy odour (Government of Australia, 2016). ● This fungus germinates readily in the soil and can spread from soil level (Government of Australia, 2016). ● The fungus is still spreadable after harvest (Government of Australia, 2016).
Spot blotch	● Can cause yield losses between 25% and 43%, depending on management practices and the severity of the infection (Sharma, R. C., & Duveiller, E. 2006).	● Another major fungus that affects the surface of wheat plants (Bayer, NP). ● Forms dark brown or black spots on wheat leaves and stems (Bayer, NP). ● Forms spores and spore containers (ascotheciums) on the surface of leaves, to further spread the fungi (Bayer, NP).
Aphids	● Virus transmitting (Stevenson *et al*., 2007). ● Large populations can stunt growth of the crops (Ophardt, 2014).	● Large and smothering colonies of black insects (*A.craccivora*) or green insects (*A. pisum*) (Stevenson *et al*., 2007). ● Spotty yellow discolouration on the underside of the leaves (Guerrieri *et al*., 2008). ● Distorted, curled, or deformed leaves (Ophardt, 2014). ● Growing points and young leaves are deformed (Stevenson *et al*., 2007).
Bud blight	● Death of the plant (Pande et *al*., 2005). ● Can cause 50-70% loss in yield (Hassan *et al*., 2012; Pande *et al*., 2005).	● Brown lesions (Pande et *al*., 2005). ● Necrotic concentric rings within the lesion area on young leaves (Pande et *al*., 2005).
Yellow	● Decreases plant height (Khattak *et*	● Yellow speckling along the veins and on the

mosaic virus	*al*., 2000). ● Reduction in number of pods per plant (Khattak *et al*., 2000). ● Decrease in grain yield per plant (Khattak *et al*., 2000). ● Reduction in seeds per pod (Khattak *et al*., 2000).	blades of the leaf (Bashir *et al*., 2006). ● Whole leaves become yellow (Bashir *et al*., 2006). ● Pods become thin and curled upward (Bashir *et al*., 2006).

Table 3. Evaluation of recommended IPM practices (resistant cultivars, increasing drainage, culling and burning) to manage Wheats Rusts (*Puccinia sp.*)

	Wheat Rusts		
Evaluated Components	Resistant Cultivars	Increasing Drainage	Culling and Burning
Sustainability	Yes. Growing resistant cultivars have no more environmental impact than growing other cultivars of wheat and do not require chemical inputs.	Yes. Increasing drainage on a farm is a sustainable management practice. It is, however, important for the farmer to be aware of where the excess water will go.	No. This is not a sustainable management practice. Burning the plant material is harmful to the environment and the soil.
Accessibility	No. These cultivars are often more expensive than common ones. They also must be bought and monitored by the companies that created the cultivar.	Maybe. This is dependent on the size of the farmer's field, as larger fields may require more labour. As a result, it is dependent on the cost of labour.	Yes. It is very accessible. It is a commonly used management practice because of its simplicity, ease of implementation and low cost.
The effect on human health	No. There are no negative health consequences for using this practice.	No. There are no negative health consequences for using this practice.	No. There are no negative health consequences for using this practice.
Culture	No.	Yes.	Yes.

Table 4. Evaluation of recommended IPM practices (resistant heirloom cultivars, cover cropping with chickpeas, and increasing drainage) to manage Karnal Bunt (*Tilletia indica*).

	Karnal Bunt		
Evaluated Components	Resistant Heirloom Cultivars	Cover Cropping with Chickpeas	Increasing Drainage
Sustainability	Yes. Growing an heirloom cultivar has no detrimental impact on the environment.	Yes. Growing a cover crop on a field, when it is not in production, does not result in negative impacts on the environment. It also helps to manage water and enrich the soil.	Yes. Increasing drainage on a farm is a sustainable management practice. It is, however, important for the farmer to be aware of where the excess water will go.
Accessibility	Yes. There are resistant cultivars of wheat that are endemic to the Punjab region, which are grown there. These cultivars are often no more expensive than average seeds because they are not patented.	Maybe. The cost to buy seeds for a cover crop and the labour to work them is costly. Chickpeas, however, can still be eaten and harvested. In addition to this, they can help pay for themselves by enriching the soil and granting higher wheat yields.	Maybe. This is dependent on the size of the farmer's field, as larger fields may require more labour. It is also dependent on the cost of labour.
The effect on human health	No. There are no negative health consequences for using this practice.	No. There are no negative health consequences for using this practice.	No. There are no negative health consequences for using this practice.
Culture	Yes.	Yes.	Yes.

Table 5. Evaluation of recommended IPM practices (resistant cultivars, timing and increasing drainage) to manage Spot Blotch (*Cochliobolus sativus*).

	Spot Blotch		
Evaluated Components	Resistant Cultivars	Timing	Increasing Drainage
Sustainability	Yes. Growing resistant cultivars have no more of an	Yes. Carefully timed planting and harvesting	Yes. Increasing drainage on a farm is a sustainable management

	environmental impact than growing other cultivars of wheat, and they do not require chemical inputs.	by wheat farmers can control spot blotch, with no detrimental effect on the environment.	practice. It is, however, important for the farmer to be aware of where the excess water will go.
Accessibility	No. These cultivars are often more expensive than common ones. They also must be bought and monitored by the companies that created the cultivar.	Yes. Timing is accessible to all farmers and has no extra inputs that would need to be purchased.	Maybe. This is dependent on the size of the farmer's field, as larger fields may require more labour. It is also dependent on the cost of labour.
The effect on human health	No. There are no negative health consequences for using this practice.	No. There are no negative health consequences for using this practice.	No. There are no negative health consequences for using this practice.
Culture	No.	Yes.	Yes.

Table 6. Evaluation of the recommended IPM practices (crop rotation, timing of planting, and intercropping) to manage the spread of aphids (*Aphis Craccivora* and *Acyrthosiphon Pisum*).

	Aphids		
Evaluated Components	Crop rotation	Timing	Intercropping
Sustainability	Yes. This practice is sustainable. Many pests have preferences for specific crops, and continuous growth of the same crop guarantees them a steady food supply, so that populations can increase. In rotations, farmers can also plant crops, like soybeans and other legumes that can break the pest life-cycle, as changing the crop	Yes. Timing is a sustainable practice as it is a proactive way of ensuring that plants do not coincide with a pest's growth. It does not require any chemicals to be sprayed on the plants, and it is a method that can be used in long-term.	Yes. Intercropping is a sustainable practice, as it can be used over time and it does not cause damage to the environment. Intercropping is used to reduce weeds and to encourage plant diversity, in order to avoid insect and pest infestation, and to provide shade, nitrogen fixation, and other benefits to the plants being grown.

	to a non-host species would deter the pest from living in that environment and thereby, reducing the need for chemical pesticides. In addition, crop rotation can replenish plant nutrients, thereby also reducing the need for chemical fertilizers. This practice has no detrimental effects on the environment.		
Accessibility	Yes. Crop rotation is accessible, since the desired crops used in rotation can be specific to the region.	Yes. Timing is accessible as the farmer is just changing the sowing time for their crops.	Yes. Intercropping is accessible, since the desired crops used in rotation can be specific to the region.
The effect on human health	No. Crop rotation would minimize the usage of chemical pesticides, as it is pest management technique, and it does not have any negative effect on human health.	No. There are no effects on human effect with changing the timing of crop planting.	No. There are no effects on human health with intercropping.
Culturally appropriate	Yes.	Yes.	Yes.

Table 7. Evaluation of the recommended IPM practices (crop rotation, removal of plant residues and increased spacing between crops) to manage the spread of bud blight (*Ascochyta rabiei*).

	Bud Blight		
Evaluated Components	Crop rotation	Removal of plant residues	Increase spacing between crops
Sustainability	See table 6	Yes. Removing plant residues from the field is sustainable, as this is an easy management technique that can be sustained over the long-term. It has no negative consequences on	Yes. Increasing spacing between the crops would decrease the micro-climate that is needed for the bud blight to grow, this is a sustainable practice as it does not involve any chemicals or practices that can harm

		the environment.	the environment. In addition, this is an easy management that can be continuously utilized in long-term.
Accessibility	See table 6	Maybe. This could be an accessible management technique, as it depends on the size of the farm. If it is a small-field, it is accessible as it would not take much labour to pick up the plant debris. If it is, however, a large farm, the increase cost of labour may discourage the farmer to use this management practice.	Yes. This is an accessible management practice, as there are no required equipment or items for this practice. It can be easily implemented.
The effect on human health	See table 6	No. There are no negative health consequences for using this practice.	No. There are no negative health consequences for using this practice.
Culture	See table 6	Yes.	Yes.

Table 8. Evaluation of the recommended IPM practices (crop rotation, removal of plant residues and increased spacing between crops) to manage the spread of yellow mosaic virus.

	Yellow Mosaic Virus		
Evaluated Components	Removal of infested leaves with whitefly larvae	Weeding	Plant resistant cultivars
Sustainability	Yes. Removing the leaves that are infested with whitefly larvae by hand is a sustainable management practice as there are no chemical pesticides involved. It has no negative consequences on the environment.	Yes. Weeding is sustainable, as this is an alternative to using chemical herbicides. As a result, there would be no chemicals being used on the crops. Thus, there would be less of an impact on the environment. This is a	No. Planting resistant cultivars is sustainable, as the plants would be resistant to the yellow mosaic virus. Thus, chemical pesticides would not be needed and there would not be any negative consequences on the environment. This is, however, not a technique that can be used in long-term, as the vector/host of the yellow mosaic virus can become

		practice that can be used in the long-term.	resistant to the plant with the gene.
Accessibility	Maybe. This is dependent on the size of the farmer's field, as larger fields may require more labour. It is also dependent on the cost of labour.	Maybe. This is dependent on the size of the farmer's field, as larger fields may require more labour. It is also dependent on the cost of labour.	No. Resistant plant cultivars are not native to the region, and thus, to use this practice, the farmer would need to purchase the seed/plant. As a result, this implies that the practice would not be accessible to some farmers, since costs are involved.
The effect on human health	No. There are no negative health consequences for using this practice.	No. There are no negative health consequences for using this practice.	No. There are no negative health consequences for using this practice.
Culture	Yes.	Yes.	No.

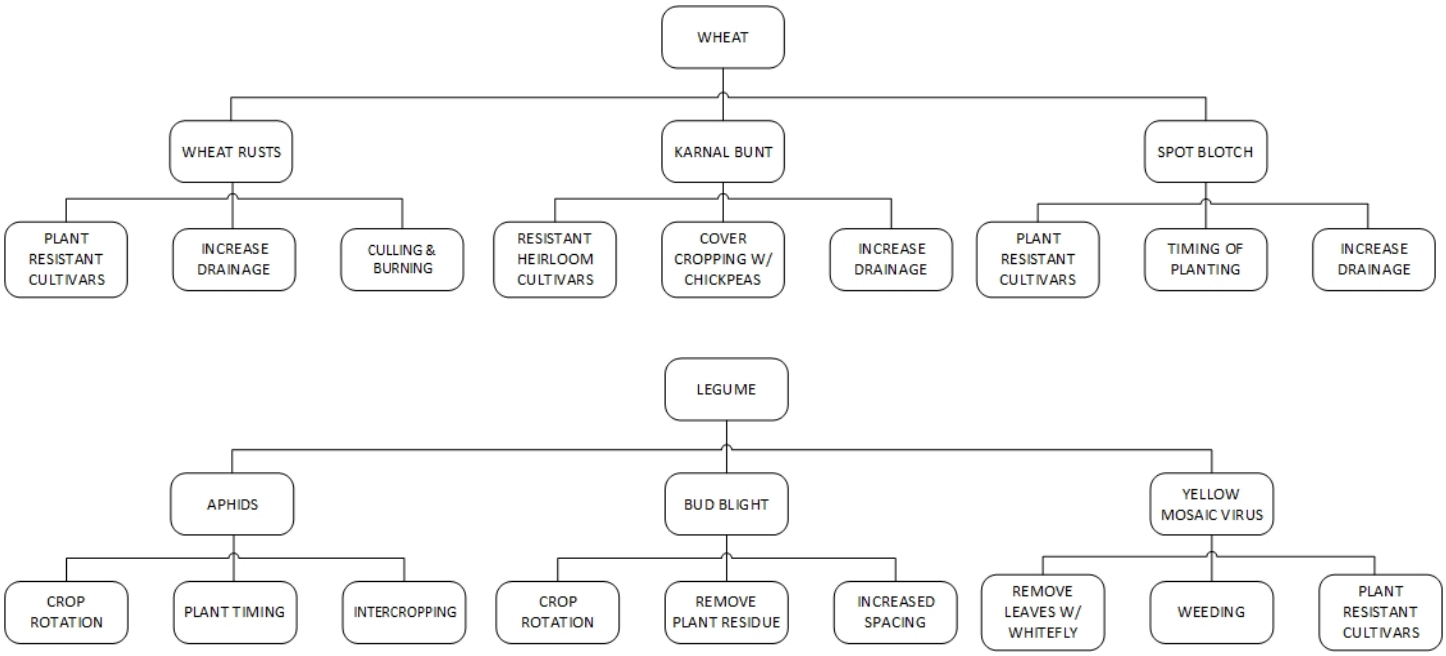

Figure 2. Takhti formatting of wheat and lentil pests and their associated best management practices.

Discussion

This community project was approached with the goal of empowering farmers and communities in Punjab, Pakistan, to have a right to a healthy and safe work environment, as well as greater access to their right to grow, sell, and eat nutritious foods, which are affordable and culturally-appropriate, through sustainable and alternative means to synthetic pesticides. By recommending IPM practices that focus on controlling pests, which damage the communities' most essential crops, we hope to potentially increase and sustain food justice in Punjab, Pakistan. The following paragraphs will discuss how this project progressed to answer our original research objective (see *Objectives* section).

In the beginning of the Green Revolution, synthetic pesticides were very effective in removing pests on major crops, such as lentils and wheat, in Punjab, Pakistan. The local pests for these crops, however, are now becoming pesticide resistant, which has caused farmers to integrate multiple types of pesticides, at the same time, and use more than the suggested dose for their crops to maintain pest control (Khan *et al.,* 2015a). Furthermore, their traditional farming practices, which include burning crop residue after harvest, release vapourized pesticides into the air that the local communities inhale, causing abnormal development in bones and tissues and diseases such as osteoporosis, thyroid cancer, endocrine disorders and so forth (Khan *et al.*, 2015b; Irfan *et al.*, 2015). Although the Punjabi farmers experience numerous health issues due to the excessive use of chemicals, this practice is the best pest control method they know of (Khan *et al.,* 2015a). Aside from programs such as the Nat-IPM that was available from 2001-2004, which functioned to educate farmers about possible IPM practices in place of chemical agents, especially for cash crops like cotton, no academic materials have been found on current IPM practices developed in Pakistan for wheat and lentils (Siddiqui *et al.*, 2012).

For the two target crops in this project, IPM practices include growing resistant cultivars, heirloom crops, cover crops, as well as implementing crop rotation, intercropping, removing plants and infested residues, weeding, increasing drainage, and adjusting sowing times. They pose no detrimental threats to the environment and can be done without utilizing additional

chemical agents (see Tables 3-8). These practices are applicable to the top three most common pests for wheat and lentils, which were identified in the *Results* section. They can be used separately, or be integrated with one another to maximize control, to accommodate the characteristics of a specific farm, its crops, and the various pests it may be subjected to. Additionally, culturally-appropriate IPM practices suitable for pest control in wheat and lentil crops, have also been included such as the culling and burning of crops (see Table 3-8). This recommended practice is culturally-appropriate and has been a traditional Punjabi farming technique. It is, however, not sustainable as it pollutes the air and damages the health and wellbeing of local Punjabi families and farmers (Irfan *et al.*, 2015). It should be noted, that the Punjabi farmers have the choice to use any of the recommended practices, including the practices that may not be sustainable, but are culturally-appropriate.

Our recommended practices for pest management can allow the Punjabi farmers and communities to restore their entitled rights to cultivate culturally-appropriate, sustainable, and accessible nutritious foods, which do not compromise their health, safety and well-being, unlike the negative effects of using synthetic pesticides. Moreover, our pest management recommendations can potentially aid in increasing food justice among Punjabi communities and farmers.

Lastly, in Table 9, our group discusses the various limitations and challenges we confronted in our research, as well as recommendations to improve future research on IPM practices in Punjab, Pakistan.

Table 9. A discussion on the various limitations and challenges our group confronted when conducting our research and working with our community partner.

	Communication	Research	Length of Study
Limitations	● Lack of direct communication with Punjabi communities in Pakistan.	● Lack of information on existing pest management practices with a culturally-appropriate lens on pest management practices in Punjab, Pakistan.	● Lack of sufficient time to do the research. Our research had approximately 3 months to be completed, which was not a lot of time to

			complete all our needed research.
Negative Effects of the Limitations in this Study	● Contributed to the limited perspectives in our research (i.e. lacking the Punjabi community members' voices). ● Unable to gather recent information on existing pest management practices that are culturally distinct to Punjabi farmers in Pakistan.	● Inhibited our ability to fully develop agroecological pest management practices that are culturally-appropriate for Punjabi farmers in Pakistan.	● Contributed towards limitations in communication, because our research was only 3 months long, and it did not allow for the adequate time required in communicating and researching about the communities in Punjab, Pakistan
Corrective Actions Applied During this Study	● Relied on any direct communication between our community partner, LET'S, and Punjabi communities in Pakistan, but because of the long-distance and time differences, information retrieval was slow, and beyond the time we could afford.	● Relied on a few, dated academic papers, that observed existing Punjabi pest management practices through a culturally-appropriate lens.	● Redirected our focus to no more than two crops, and three pests for each of the selected crops.
Future Approaches to Minimize Limitations and Negative Effects	● After this research experience, we understand now the communication limitations in studying populations that are far away, and in the future groups should make an effort to reach out towards their community partner as early as possible to compensate for the slow information-retrieval time.	● In the future, it is important to connect with Punjabi communities first-hand, in Pakistan, in order to understand present-existing pest management practices through a culturally-appropriate lens.	● In the future, groups should develop a schedule for the community project as early as possible, because it is critical in better understanding the limitations of the available resources, and working around these limitations in a timely manner. This is a corrective action that can be applied immediately.

Conclusion

Our project has highlighted the importance of reducing pesticide-use for the long-term, well-being, safety and independence of farmers and communities in Punjab, Pakistan. Our project has also added to the existing knowledge, through our IPM recommendations, geared towards alleviating the effects of pesticide-use on the health and well-being of Punjabi communities and farmers.

We decided that in recommending IPM practices, it was important to acknowledge and incorporate any existing "cultural" farming practices in the Punjab region into our recommendations. There are only a few sources of information on the current, culturally-appropriate and local pest management practices in the Punjab region, which made it difficult to incorporate the culturally-appropriate and local knowledge into our research. As a result, more research should be gathered on culturally-appropriate farming practices and local pest management in Punjab, Pakistan. Moving forward, we recommend further research to obtain insight into the financial feasibility of our recommendations, and if the recommended pest management practices can be appropriately integrated into the farming communities of Punjab, Pakistan.

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Appendix

Critical Reflections:

Student 1:

Of all the struggles our group encountered, I was especially troubled by how my background and expertise (or major, which I will not name) could not benefit my team like other pest management related or global food systems related majors. I was incompetent in many aspects of this project which we had to research about and this was a major setback in my ability to perform 100% in my team's interest. This is why I am especially thankful for the multiple flexible learning classes that allowed me to better connect with my team members and discuss how I can be of use.

My experiences acquired in the CBEL project were more than I had expected to walk away with. I had not expected the overwhelming and unending waves of uncertainty that was evident throughout the project, especially because we had no direct contact with the locals in Pakistan. This really gave me an opportunity to comprehend the realities of life outside of education slightly more. Due to group work, which is unavoidable in almost all workplaces, I had a chance to understand my strong and weak points, and how to conform my abilities to suit our community partner and my teammates' intentions and interests.

Student 2:

First and foremost, I enjoyed the lectures this term for LFS 350, I particularly enjoyed the lecture on Aboriginal sovereignty. The reason why I found the lecture on Aboriginal sovereignty so fascinating was that it was presented from the perspective of an Aboriginal individual, who helped elucidate what sovereignty means within their nation. This phenomenon is quite a rare experience in the Western academic education system. Concurrently, I found learning about food justice, through a gender, race, social justice lens also useful, because often in university we treat all faculties as being individual silos of education, where other disciplines seldom intersect with one another.

This term, I found that the teaching team provided excellent feedback to our assignments, and more importantly the teaching team was always open to receiving feedback regarding them teaching methods and the course as a whole. I feel that this is what makes LFS exemplar compared to other faculties, which is the reciprocity of constructive criticism and the ongoing push for improvement in all aspects of the course.

One aspect I would change, specifically with regards to our project, is the commitment of our community partner to help us. Unfortunately, I found that our community partner made promises that they were unable to follow through with. At the same time, I felt that communication between our group and our community partner was quite poor, in that when we sent emails to our community partner, they would either infrequently or never respond to our emails.

Student 3:

I really enjoyed the LFS 350 lectures as they connected directly with our tutorial content, allowing our teaching assistant to smoothly transition us into our group work. The guest lectures were the most beneficial as they allowed me to really connect with the material and explore applications in our community.

This term working with a community partner proved to be a test, I was not aware of the challenges that could arise from communications. The community we were working in was situated in the Punjab region of Pakistan, making it difficult to establish a line of exchange where we could gain information and insight. Furthermore, this translated into our direct work, as having little information made significant room for our recommendations to be inconsistent with the practices already in place in the community.

I had difficulty applying my teachings in the project as someone who was not an applied biology major. Of course each of our disciplines were connected under the same umbrella, though the bulk of the work stayed heavily under the applied biology realm. It made me feel as if I was not applying myself into the work as my fellow group mates, and I would say created gaps between my knowledge rather than fill them in. Especially, with the limited time within the course it became difficult to deviate and look into different ways of applying knowledge when they clearly did not fit into the framework.

Student 4:

I am very appreciative to have been able to experience working on a CBEL project with LET'S and such dedicated team members. The CBEL has been an interesting learning experience that united the knowledge from traditional lecture-based education and the real-life application of such knowledge. In addition, I have acquired skills that were not taught in a lecture setting, such as planning and creating proposal and collaborating with a community partner. This project has had a large emphasis on working effectively in a group, which has proven a revelation on the difficulties and subsequent successes that have arisen from an uncomfortable situation.

I have found the flexible learning sessions to be very helpful in allowing us a specific time set out to have meetings with Saadan and to discuss and allocate tasks within the group, especially when a significant proportion of this project is based on literature review online rather than meeting with the farmers of Punjab, Pakistan in person. However, since most of the work is done online, I have found it at times difficult to communicate with our community partner,

which relied on Saadan to act as the middle-man with LET'S partners in Pakistan. Due to the time constraint of our project, we were not able to garner any information about the current pesticide practices in Punjab, which would have been helpful in identifying the appropriate management practices in the area. Despite this, it was an invaluable experience that highlights the difficulties in working with multiple groups.

Student 5:

Having the opportunity to work outside the classroom in a community-based learning (CBEL) project and using it as a teaching strategy in LFS 350 to facilitate our learning was a valuable experience. The lectures, tutorials, and the flexible learning allowed us to find the connection on what we learned in class to real world settings and to apply it to the community. I am grateful for the time given to us with the flexible learning as this helped with time-management and made it easier to meet-up as a group to work on our CBEL. Moreover, the chance to collaborate with the hard-working people in my group made the entire experience rewarding as we become each other's strengths and help with each other's weaknesses.

The chance to have a real community project made me more connected towards to project than other project in classes which were more theoretical/hypothetical. However, I felt like this project somewhat limits our learning and our ability to connect our learning in LFS 350 compared to other groups. It was hard to create a meaningful connection to the community when we are unable to physically speak and connect with them. Furthermore, it wasn't as enjoyable or fun as all we did was research on the computer and we didn't have an opportunity to actually go out and be part of a community. It was also frustrating with the lack of communication when trying to find more about the cultural and traditional pest management strategies that the region used. Communicating and recording our process on a blog was a new experience for me and it was a good and fun way to share our information to the public instead of an essay or report to just the professor. Using the blog made the project more "real" and connected us to the project. Overall, I feel like this course gave me valuable skills and experiences in teamwork, problem-solving skills, and critical thinking.

Student 6:

Overall I have enjoyed our community project this year and reveled at the opportunity to experience as less conventional learning environment for a change. The idea of a CBEL is fantastic and I think it helps students a realize that they possess skills that are valued and useful in the working world. I believe it is crucial to have the flexible class time to put more collaborative work into the project, this project would not be nearly as complete and thorough if we had not been able to meet regularly and in person, but I believe I would have understood the content more if we had more discussions in our tutorials about them. I also found it difficult to engage with the extra material when it did not directly address our project. Another problem I had was with the blog system. It felt over complicated and sort of unnecessary, perhaps that is because of the distance between us and our community, but I felt as though no one was seeing what we were writing and it began to feel a bit redundant. In all I enjoyed the structure of the class, however there are some changes that could be made to help students produce a higher quality report.

I would like to add few things, I believe the nature of our project (i.e. working with technology community partner, focus on Pakistan) that the Community part of our CBEL was extra challenging. We had an extremely busy contact with LET's and we could not communicate directly with our targeted communities. We found it challenging to find many of the cultural or community based sources to include in our research. This made it difficult to engage with the blog, and to meet some criteria that asked for community sources. Although the community aspect was limited I believe we got a lot of experience working on this project, and I particularly enjoyed the subject matter which helped me enjoy the project more. In all I enjoyed the topic and style of the projects, and the lectures in class, but I found it challenging working with our community partner.