# URBANIZED INVASIVE HOUSE SPARROWS BENEFIT BY HAVING FLEXIBLE DIETS

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## ABSTRACT

House Sparrows (*Passer domesticus)* are an invasive species that are commonly found across North America and many other continents. Originally, they were studied for their adaptations to biotic conditions, but over the years, House Sparrows have served as a focus for studies portraying their success as invasive species. Like many invasive species, their diets can consist of different types of feed depending on what's available to them. In our experiment, a field study was conducted to determine their seed preference. We set out five different types of feed to observe what the House Sparrows would prefer. Our results showed that House Sparrows prefer corn over all other four feed types that were offered, including sunflower seeds with and without the husk, millet, and safflower. Being flexible in their diets allows invasive species like House Sparrows to thrive in novel environments. Our results provide experimental evidence for the importance of variable social connections when examining House Sparrows by using multiple food sources.

Keywords: Behavior; Diet; House Sparrows; Invasive species; Urbanization

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## INTRODUCTION

Biological invasion is a major cause of biodiversity loss and environmental change. Invasive species threaten our native plants and animals by competing for food, water, and space damaging habitats (Martin et al. 2005). Damage and loss triggered by invasive species and the cost of control measures also result in a high and rising economic and environmental burden. (Hejda et al. 2009). Invasive species affect the economy by impacting fisheries, forest protection and reducing grazing land and crop yields. As humans evolve our exporting methods, foreign species have become more prevalent (Colleony et al. 2020). Multiple studies have shown that climate change can enhance plant invasion from regional to global scales (Ronald et al. 2005). However, ecologists and scientists have been working to prevent and control plant invasion issues. The majority of areas have received significant research attention over the past years based on habitat distribution of invasive plant species (Gallinat et al. 2020). Further studies have shown not all exotic species are considered harmful, non-native species can have neutral effects on other species (Demeter et al. 2021).

House Sparrows are absent from undisturbed forests, but they're common in urban areas (Tuliozi et al. 2018). Invasive birds contribute to over $2.3 billion in damage to agriculture (Pimentel et al. 2001). Invasive birds include the Common Starling (*Sturnus vulgaris*), House Sparrow (*Passer domesticus*), Egyptian Goose (*Alopochen aegyptiaca*), and many more (Martin et al. 2005). Invasive birds are capable of adapting into any environment. Species hunt for food sources based on their environment conditions. These factors are based on physical limitations, predator abundance, and competitor abundance. Humans influence a variety of environmental factors when moving into cities and expanding their land (Wang and Liu, 2021). Urbanization leads to rapid and dramatic reductions in abundance and diversity of wildlife, because species are pushed out of their natural environments (Martin et al. 2005). Invasive birds have often acquired unique traits including fast growth, rapid reproduction and high dispersal ability that allows them to flourish and prosper in new lands. House Sparrows were introduced to the US back in the 1850s. They started in Brooklyn, NY, to control the caterpillar population, which would reduce the number of moths that were destroying the city's basswood trees (Lowe 2020). However, about half a century later, House Sparrows successfully invaded the rest of the country. In their peak back in 1940, 150 million House Sparrows were inhabiting America (Lowe 2020).

One factor determining invasive success within a non-native species is diet type. Animals with a broad diet are likely to be more successful in invading new areas (Shik and Dussutour 2020). House sparrows seem to fall into this category as they will eat almost anything which makes them notable invaders (Shik and Dussutour 2020). A species that requires a specific food type would be more restricted to certain habitats and would be less likely to survive as an invasive species because of dietary restrictions. The wide diet variety of the sparrows is a helpful trait that will increase their chances of survival in a new environment. When eating a wide range of seeds, they can adapt to almost any environment and effectively invade it which could harm the native species and could possibly force them to extinction (Chichorro et al. 2019). This shows that the sparrows will have food preferences when many selections are available, but they won't require a vast food selection to survive in a specific habitat or invade a new one.

Another factor is how much longer the native species has been in an area compared to the invasive species. If the House Sparrows are introduced long after the native species have already flourished, their invasive success may be reduced (Hess. et al. 2019). House Sparrows will eat a variety of organisms including insects, such as caterpillars, and different plants and berries that are found in their habitat. Although House Sparrows are known to eat a wide variety of foods found in nature, they do have a preference of choosing to eat from bird feeders. A study conducted on the Purchase College campus found that sparrows preferred to eat from bird feeders rather than nearby invasive or native plants. When bird feeders are set out, the House Sparrows tend to gravitate more to them since they are an easy to access food source (VanHouten and Yates 2018).

In our study, we tested five different types of birdseed to which ones were preferred by House Sparrows when they chose which one to eat. The choices were sunflower seeds with husks, bare sunflower seeds, millet, cracked corn and safflower seeds. We observed which seeds the sparrows preferred on five different days. All of these tests were conducted outside the humanities building which is where there is a high density of sparrows. We considered the variables such as weather, wind and protests that were taking place on campus and acknowledged that these factors could influence our results. It was predicted that the millet seed would be the most popular because it is not only the smallest seed but the most prevalent ingredient in the mixed seed.

## METHODS

*Experiment setup*. Data was collected Oct. 18-29th, 2021. The data collection site was located on SUNY Purchase campus (Fig.1). We collected our data behind Purchase College library because of the large population of house sparrow (*Passer Domesticus*) birds found there. In total, we used five bird feeders to determine which food type House Sparrows prefer. The food options were Feathered Friend premium black oil sunflower seeds, Kaytee cracked corn, White Proso millet seeds, Lyric sunflower kernels, and Wagner's safflower seeds (Fig. 2).


Figure 1. A Map of Purchase College showing the location of the data collection site.

*Field setup.* We placed the feeders approximately one foot away from one another. Then, we stayed approximately twenty feet away to allow the birds to eat from the feeders. To collect the samples, we counted how many birds ate the seeds from each of the feeders. After completing the first sample, we changed the order of the feeders by shifting them to the left to see whether the order of the feeders affected what seed they prefer (Fig. 3).

Figure 2. Types of seeds used for the feeders. Left to right: sunflower (with husk), cracked corn, millet, sunflower bare, and safflower

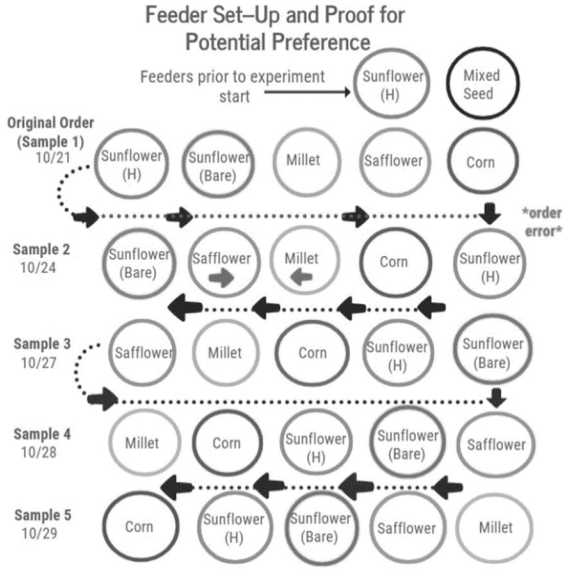


Figure 3. A display of our feeder set up per sample with location of original feeders for reference.

*Data collection*. Due to temperatures and external noise including construction and students, we collected samples for different amounts of time. On October 21st, we spent 2 hours collecting data. On the 24th and 27th, we were able to collect data for an hour each. On the 28th, we collected for an hour and twenty minutes, and on the 29th we observed for only 40 minutes due to bad weather and lack of sparrow presence. We removed the feeders after each sample we collected because the area was used by other students conducting different projects. Before conducting this experiment, a mixed seed feeder was placed on the collection site from another project. Throughout the sampling dates, temperature ranged from 55 to 68 degrees fahrenheit. The weather was mostly cloudy, windy, and foggy with occasional sunshine.

*Statistical analysis*. We used Microsoft Excel to create bar graphs to analyze our data. In total, two graphs were created for each of the samples. Also, we used google maps to indicate the region of the collection site. The results were calculated seeds/hour in order to compare inconsistent data collection times because some samples lasted more than one hour.

## RESULTS

Over the course of our observations, we found that a total of 373 birds visited the cracked corn feeder. 279 birds went to the sunflower seeds with the husk and 138 went to the bare sunflower seeds. Next, 116 birds went to the millet feeder. Lastly, a total of only 58 birds went to the safflower feeder. This emphasizes the preferred choice in cracked corn and sunflower seeds with the husk over the rest of the food (Fig. 4).

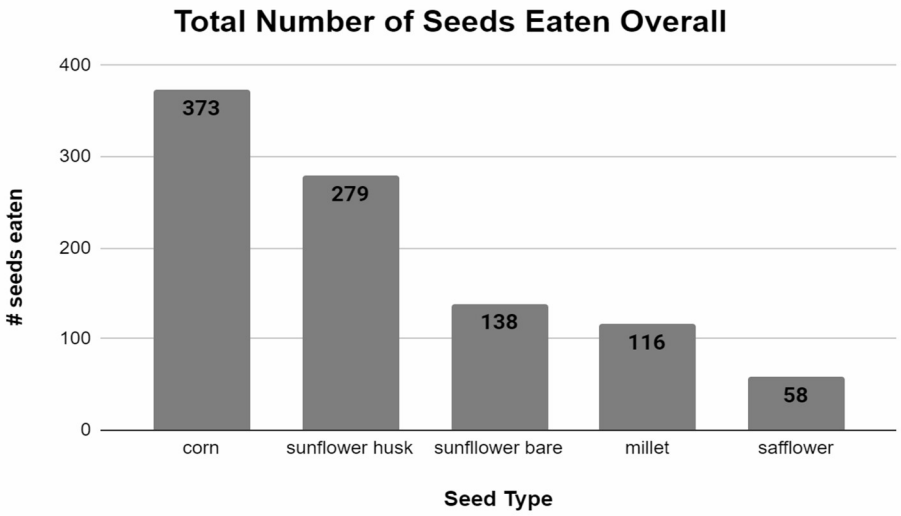


Figure 4. A table with the total number of seeds eaten in total throughout all five samples

In trial one, the weather was sunny and warm, and the House Sparrows preferred the cracked corn the most which had 70 birds visit per hour. The sunflower seeds with the husk were the second most preferred with an hourly average of 55 birds and after that was the bare sunflower seeds and the millet. The bare sunflower seeds had 7.5 visits per hour and the millet had 3.5 visits per hour. The House Sparrows did not prefer the safflower as much with only two birds gravitating towards it per hour (Fig. 5).

The second trial lasted for an hour and the weather was cloudy and gray. We found that during this trial the most preferred became the sunflower seeds with the husk. 70 birds flew to that feeder during the hour. Cracked corn became the second most preferred for the House Sparrows with 35 of them visiting the feeder. The third most preferred were the bare sunflower seeds which 23 birds visited. The last two types of feed that the birds preferred were the safflower and the millet. The safflower had 11 birds gravitating towards it and the millet only had 10 (Fig. 5).

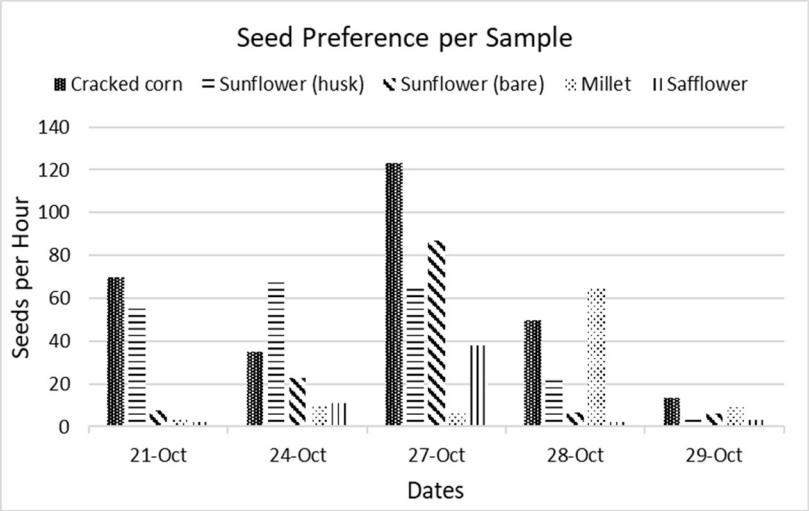


Figure 5. A chart comparing the number of seeds eaten per hour, per sample.

Our third trial was an hour long. On this day it was windy and there was construction occurring. Although it was across campus, the noises could still be heard from the feeding station. Within this trial, the cracked corn was the most eaten feed with 123 birds visiting the feeder over the hour. The second most eaten feed was the bare sunflower seeds. This feeder had 87 birds visit it. Third is the sunflower seed with the husks that had 66 birds visit it, and fourth is safflower with 38 birds. The birds did not prefer the millet as much with only seven birds visiting it (Fig. 5).

The fourth trial was an hour and twenty minutes long. On this day the weather was sunny and warm with a minimal amount of wind. During our trial, there was a protest going on across from the feeders. It took the birds a total of 35 minutes from when we started our observation to start coming to the feeders. Since this was different from our normal experiences, we have reason to assume it has something to do with the loud voices and heavier than usual foot traffic. The millet feeder had 64.5 birds visit it per hour, making it the most preferred feed of this trial. The second most preferred feed was the cracked corn that had an hourly average of 49.5 birds visit. Third was the sunflower seeds with the husks with 22.5 birds per hour, and fourth was the bare sunflower seeds that had 6.75 birds per hour. The least preferred was the safflower with only 2.25 birds per hour (Fig. 5).

Our fifth and final trial was 40 minutes long. This day was cloudy and windy with a chance of rain later in the day as well. Due to the excessive wind and gray weather, the birds were not as active as they normally were around the feeders resulting in a smaller number of birds in total. Throughout the 40-minute period, we had gaps of no birds going to the feeders and strong wind. We have reason to assume that the strong winds and poor weather conditions made the birds not visit the feeders as frequently. In this trial, the most preferred feed was the cracked corn with 13.5 visits per hour. Second preferred was the millet with nine visits per hour. The third most preferred feed was the bare sunflower seeds with an hourly average of six visits and the fourth most preferred feed was the sunflower with the husks that had 4.5 visits per hour. The least preferred feed was safflower with only three visits per hour (Fig. 5).

## DISCUSSION

From our results, we learned that House Sparrows prefer cracked corn over all other five feed choices, seconded by sunflower seeds with the husk still on. Third best were sunflowers, then millet, and lastly safflower was the least preferred overall. We know that food with higher fat content offers more

nutritional and energetic value for the birds, but it is not the only factor involved in their diet choices. Ideally, birds should select the food option that is easiest to eat while providing the most energetic benefit (Molokwu et al. 2011). For example, sunflower seeds tend to be high in fat while cracked corn helps to keep stable energy levels with simple carbohydrates like glucose. Birds also consider handling times (the level of effort it takes for them to eat and digest the food) when considering food options. Seed hardness normally determines how much time it would take for the birds to crack open the husk to get to the seed itself (Van Der Meij et al. 2004). We presumed the birds would prefer the bare sunflower seeds over the ones with the husk still on due to this factor, but further research would be required to see whether the bulk of the nutritional benefits of sunflowers is contained within the seed casing or the seed itself, or if they simply chose the husk seeds out of familiarity.

With every trial, we rotated the feeders to see if there would be any preference in the feeders towards the end of the line where the original two feeders were set up before our project began (Fig. 3). The feeder farthest to the left would be brought to the right end, and the adjacent feeders shifted left once. An error was made on the day of our second sample in which the millet and safflower seeds were misplaced. In some instances, this hypothesis seemed accurate and the feeders in the same location of the original two were preferred, as birds are known to be more likely to prefer guaranteed satisfaction over risk-for-benefit situations (Ilan et al. 2013). In other samples, one or more of the feeders in the middle had more activity than the feeders at the end, which brings us back to the idea that the House Sparrows choose their foods based on fat contents and how much energy it can provide, and less so their familiarity with its location. Overall our results were inconclusive in terms of original feeder location preference. As seen in Figure 4, there was almost always activity at the far right feeder (which is one of the usual 2 feeders' spots), which may suggest familiarity, but; the safflower went near;y untouched the day it sat in that spot-making any assumptions difficult. This part of our study links to the birds' comfort with novelty situations, as they tried each new feeder to determine what type of feed is where each time we sampled. Seed size and husk characteristics are important factors in determining whether the birds will prefer the feed being offered (Titulaer et al. 2018).

Along with rotating the feeders, there were also differences in weather and foot traffic in the area per sample time. Weather wise, some days were sunny and warm, while other days were cloudy and rainy with wind. Different weather patterns, like wind strength and rainfall, have effects on bird behavior overall (O'Connor and Hicks 2009). The wind and rain tended to affect the birds and their drive to get food, as high winds and rain hinder flying abilities for many flying organisms. On days such as those, we got less data than normal. When it came to foot traffic, there were many different sounds in the area during each trial. Loud, sudden noises and human proximity to the birds would affect their boldness in going to the feeders. For instance, during one of the trials there was a protest going on directly across from the feeders, the noise and density of people made the birds hesitate to return to the feeders as frequently as they usually did. On other days, the sounds of skateboards rolling by and people talking made the birds flee from the feeders while they were eating, but they returned with enough frequency to account for the numbers we saw in our results. We observed the sparrows' behavior as well as their food choices, becoming increasingly comfortable in novelty surroundings such as a protest on campus. The birds could have been perceiving the louder noises as risks causing them to be as cautious as possible. Bird behavior can be impacted by predation risks and landscape connectivity which can, in turn, impact where they choose to live and get food (DeWitt et al. 2018). Once they noticed that there was no real risk, they went back to the feeders as they normally did.

The errors we encountered included the aforementioned accidental misordering of the safflower and millet seeds, as seen in figure three, as well as the weather and unforeseen campus activity going on during our intended observation times. It is important to clarify that although our results are accurate, as we counted the number of bird landings on each feeder, it does not reflect the true number of birds in the flock, nor does it prove how many individual birds may have landed there. The same bird(s) could have

landed on a feeder multiple times, and would be accounted for as so, as we had no way to mark each bird to see if some were bolder than others in trying new foods.

There are many ways to replicate and improve this project, like studying different species of birds either simultaneously or individually, testing over a span of different seasons or locations. It is important to note that birds are also sensitive to and usually aware of the secondary compounds found in many of their feeds, especially those made in factories (Molokwu et al. 2011). Birds will make food choices that take chemicals like tannins and saponins into account, which raises questions about the quality and origin of the foods they eat. Another idea would be to offer the birds human foods, but, especially in America, foods are riddled with potentially toxic additives and preservatives that may harm the birds' digestion systems. The seasons may influence the type of feed the birds choose to eat as well, depending on the activities they participate in throughout the year such as breeding and migration. It is important to test other species of birds and wildlife in general to get a sense of how we may be able to preserve their species, if necessary, as our world continues to explore the effects of anthropogenic climate change.

We know that many species are becoming more accustomed to urbanized spaces out of necessity for survival and observed the triggers that would scare the sparrows and those that didn't. For example: one or two people walking by normally wouldn't upset them, but a plane overhead, a skateboard, bike, or even a group of people passing by would send them into the trees or into the brush next to the feeders. There are many other places in which it would be useful to observe sparrows, like rural areas where adaptation to loud noise and commotion isn't necessary. This was tested by Jarjour and her peers in 2020 where both urban and rural birds were tested for their willingness to accept novelty to feed. It was determined that even with many controls to prevent variability, urbanized birds are much more comfortable facing new experiences than those from rural or less populous areas (Jarjour et al. 2020).

Research like this is important because we can link how House Sparrows tend to be good at invading. Like many other species, House Sparrows are not native to the United States; they are mainly from Europe and parts of Asia and northern Africa. They can also be found in the United Kingdom, where their population seems to be decreasing (Summers-Smith 2003). Their level of boldness and adaptability to novel environments is what makes them such good invaders; seeing as they were able to feed from all five feeders regardless of preference shows their flexibility in diet, which also puts them at an advantage to many native species. This study can help to find ways to increase the house sparrow population there by using their food preferences, or even lure them away from a fragile environment if necessary. Research like this is important because as the world continues to be changed by humans we need to know how and if wildlife will be able to adapt, as well as their behaviors and preferences to ensure resource availability and pinpoint locations where these species may be able to thrive.

## CONCLUSIONS

Our findings concluded feeder position had a minor impact on birds' preference on the seeds. Overall, the cracked corn was most popular followed by sunflower seeds with husk and bare sunflower seeds. However, when each seed was positioned at each end, there was an increase of bird visits. Even though the millet and safflower portrayed an increase of bird visitors, they were not as popular compared to the other seeds. Like many other invasive species, House Sparrows have a flexible diet which makes them successful when introduced to new environments. Because of their flexible diets, House Sparrows settle mostly in urban areas. Their population continues to expand throughout many countries. This experiment is ideal because it demonstrates how House Sparrows affect other native plant species due to their diet. Species specific experiments allow us to obtain important data needed to preserve or restore different types of species if necessary, or even lure them away from environments they may be negatively impacting.

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## AUTHOR CONTRIBUTIONS

Data Collection (all), Formal Analysis (AH, SC, GP), Data Curation (AH, SC, GP), Methodology (AH, SC, GP), Resources (all), Visualization (AH, SC, GP), Writing - Intro (AH,RO), Writing - Methods (AH), Writing - Abstract (AH, SC, GP), Writing - Results (GP), Writing - Discussion (SC, GP), Writing - Conclusion (AH), Writing - Acknowledgements (all) , Writing - Charts and Tables (SC), Writing - review & editing (AH, SC, GP).

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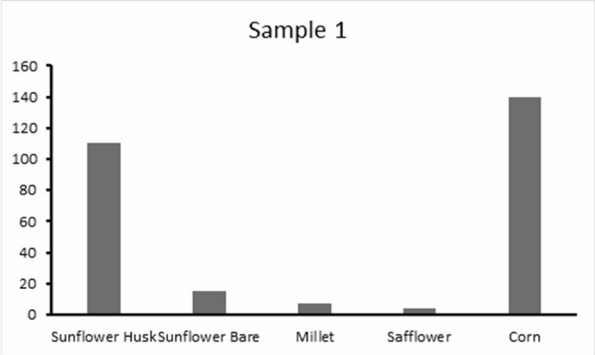


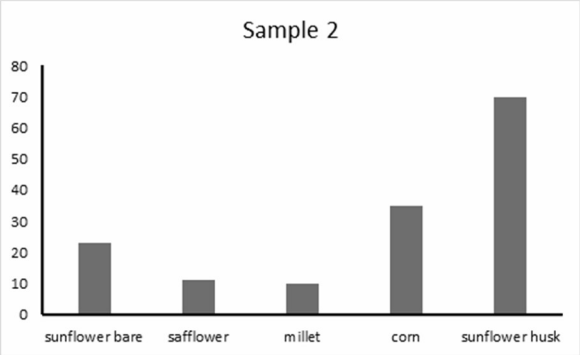


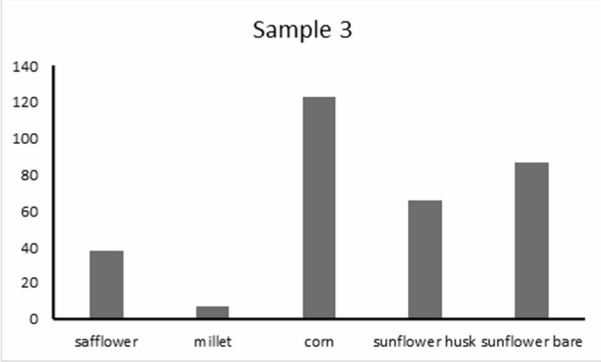


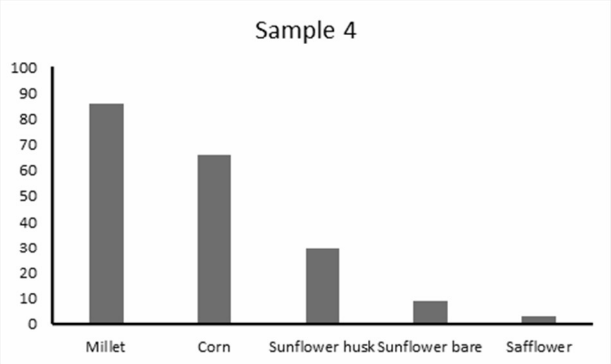


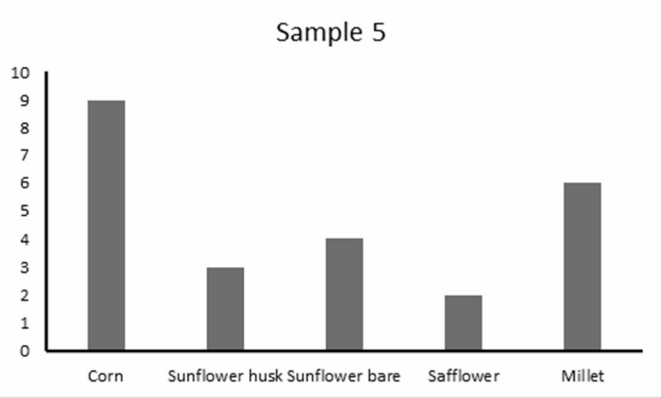


Appendix A. Graphs of all five sample results with respect to feeder location per sample.