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Combining two wrongs to make two rights: Mitigating food insecurity and food waste through gleaning operations ☆

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ABSTRACT

Two concurrent social issues in the United States are food insecurity and food waste. The practice of gleaning offers a mechanism for combining these problems to create a synergistic solution. We develop a stochastic optimization model to determine the schedule that maximizes the volume of excess crops rescued from farm fields for the purpose of feeding food-insecure households, thus maximizing social impact. We model gleaning as a service operation where donation calls arrive randomly requesting to be scheduled within a limited time window. The feature that distinguishes gleaning operations from other service settings is that there is uncertainty in both when donations will arrive and the attendance of the gleaners who are volunteers that are not obliged to attend gleaning trips. We apply our model to the gleaning operation of the Food Bank of the Southern Tier in New York State, focusing on five major crops produced in the region. By characterizing how the gleaning operation behaves, our model allows us to optimize the gleaning schedule to maximize the expected total volume gleaned and determine under which conditions different operational strategies can be most useful for improving the performance of the gleaning operation. This in turn enables us to identify conditions under which alternative policy interventions (e.g., farm donation tax credits and government grants to strengthen operational capacity) are more effective for scaling up gleaning programs.

1. Introduction

Two concurrent social issues in the United States are food insecurity and food waste. In 2014, 17.4 million households – approximately 14 percent of the total – were classified as food insecure (USDA, 2015). Moreover, there is evidence that a large proportion of households receiving food assistance may experience micronutrient malnutrition due to inadequate diets associated with insufficient consumption of micronutrient-rich foods such as fruits and vegetables (Davis and Tarasuk, 1994; Tarasuk and Beaton, 1999; Dimitri et al., 2015). A number of studies have demonstrated links between food insecurity and obesity among children and adult women living in food insecure households (Casey et al., 2006; Wilde and Peterman, 2006; Gómez et al., 2013). While a significant part of the population is food insecure, there is also a systemic food loss and food waste problem. Gunders (2012) estimates that almost 40 percent of the total edible food available for human consumption in the U.S. is lost each year. A significant portion of these losses occur at the production stage, in part because large amounts of edible fresh fruits and vegetables are not harvested from farm fields (Buzby and Hyman, 2012). An estimate shows that 6 percent (97,000 acres) of planted fruits and vegetable acreage was not harvested in 2011 (USDA-NASS, 2011; Gunders, 2012).

It seems paradoxical that food insecurity and food waste can concurrently be systemic problems, especially in a high-income country. The loss of fruits and vegetables that could improve the nutritional status of food-insecure households is particularly senseless. A natural and even obvious solution would be to combine the two problems to create a synergistic solution. The recov-

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erable wasted food could be donated to those in need and help mitigate food insecurity (Miller and Welch, 2013; Garrone et al., 2014; Halloran et al., 2014). In fact, the ancient practice of gleaning offers a mechanism for operationalizing this solution concept. Gleaning dates back to biblical times when farmers and large landowners allowed the poor to gather leftover crops from fields after the harvest. In modern times, when a farmer donates his/her crop, gleaning is generally performed by organizations (typically relying on volunteers) on behalf of food banks or pantries that serve food insecure households. Gleaning has increasingly attracted the attention of food safety networks, including food banks, as a valuable tool to simultaneously reduce food waste and alleviate food insecurity. In particular, food banks are eager to provide healthy, micronutrient-rich alternatives to processed food for food assistance recipients (NRDC, 2012). For example, gleaning programs in New York State rescued 3.6 million pounds of fresh fruits and vegetables in 2010 (Schuelke et al., 2011). Gleaning programs in Arizona, California, Ohio, and Texas have similarly rescued millions of pounds of food (California Association of Food Banks, 2011; Vitiello et al., 2014).[1]

In light of the growing interest in gleaning, we characterize the process dynamics of a gleaning operation, in order to give insights in two important areas:

1. Operating policy: Using the characterization of the gleaning process, the operating decisions (in particular, the gleaning schedule) can be optimized to increase the amount and/or manage the mix of crops rescued from farm fields for the purpose of improving the nutritional status of food-insecure households.
2. Effectiveness of policy interventions: Two policy interventions, tax credit for farm food donations and government support for food assistance programs, can increase the impact of gleaning operations. Characterizing the dynamics of the gleaning process allows us to understand the conditions under which each policy intervention is more useful.

Managing gleaning operations can be challenging because there is uncertainty in both the supply of food (donation from farms) and the supply of labor (volunteer gleaners). On the one hand, the gleaning operation has similar characteristics to other service operations such as health care. For example, in an emergency room, patients arrive at random times and must be treated in a timely manner (see Cayirli and Veral (2003) and Gupta and Denton (2008) for reviews of literature on scheduling the sequence of customers when arrival and service times are uncertain in health care services).

Similarly, in a gleaning operation, donations calls from farmers arrive randomly offering gleaning opportunities. Although seasonal demand can be anticipated (i.e., for a particular harvest season), the day-to-day arrival of calls from farmers during a harvest season is difficult to predict. The gleaning trip must then be scheduled within a limited time window or else the crop will perish on the field. On the other hand, the feature that distinguishes gleaning operations from other service settings such as health care, is that not only is the arrival of customers (e.g., patients or donation calls) random, but the attendance of the service provider staff is random. In contrast to medical staff who can be scheduled for specific shifts, gleaners are volunteers, and thus are not obliged to show up when a gleaning trip is scheduled. The number of pounds gleaned per trip (i.e., the processing capacity) depends on the number of volunteer gleaners that attend the trip. Because volunteer attendance is random (i.e., volunteers decide on their own whether to show up), the processing capacity of the gleaning operation is thus uncertain.

This uncertainty makes it difficult to predict the effect of a gleaning organization's deceptively simple task of scheduling the number of gleaning trips per week. Thus, we model the gleaning operation as a service operation where donation calls arrive randomly requesting to be scheduled within a limited time window. We develop a stochastic optimization model and use simulation to understand how the gleaning organization's scheduling decision affects the overall volume of food gleaned. Using this model and simulation method, we can determine the volume of output and the mix of crops that are generated on average for a given schedule.

We apply our model to assess possible scenarios for the gleaning program of the Food Bank of the Southern Tier (FBST) in New York State. The FBST's gleaning program was implemented as part of a larger effort to increase offerings of fresh fruits and vegetables to food assistance recipients. In the 4000 square mile, six-county area covered by the FBST, one out of four residents receives food assistance at some point during the year. The FBST partners with over 150 agencies to ensure that food donations reach the needy, including food pantries, soup kitchens, shelters, after-school programs, and senior housing sites, among others. Our study focuses on the gleaning of five of the major crops produced in the region: apple, cabbage, onion, sweet corn (henceforth abbreviated as corn), and potato.

Our analysis shows that there is an important interaction between the number of gleaning trips that can be scheduled in a given week (i.e., appointment capacity) and the volume of food that can be harvested by gleaners on a given trip (i.e., gleaner capacity). We find that scheduling more trips does not necessarily result in higher volume gleaned. Over-scheduling trips (i.e., setting high appointment capacity) can lead to gleaner burnout (i.e. having too few volunteers available) towards the end of the season. This not only affects the total volume of crops gleaned, it also affects the mix of crops gleaned. Moreover, the effect of gleaner burnout is exacerbated by gleaner eagerness (i.e., higher probability of a gleaner attending a trip).

Our model is relevant to the identification of policy interventions aimed at supporting food bank gleaning programs. Two operational strategies that can help the food bank increase the amount of food gleaned are: (1) increasing the number of gleaners in the pool, and (2) growing the number of farms in the gleaning network. Increasing the number of gleaners in the pool increases the processing capacity, strengthening the food bank's ability to glean more food. Alternatively, growing the number of farms in the network directly increases the amount of food available for gleaning. Characterizing the process dynamics of the gleaning operation can shed light on appropriate policy interventions to scale up gleaning programs by identifying the process bottleneck, i.e., the resource that constrains the output of the operation.

When not having enough gleaners is the process bottleneck, policy interventions to expand the volunteer gleaning pool could focus on strengthening the operational and administrative capacity of food banks. Federal and state policies could facilitate increasing capacity in food banks by offering grants and programs in support of gleaning initiatives (Farm Food Policy Project, 2007; Story et al., 2008). This is important because although the majority of funding for food banks comes from in kind contributions from individuals and organizations, a critical component to run a successful operation is to have adequate administrative capacity (Feeding America, 2015). Resources such as staff to recruit, manage, and coordinate volunteer gleaners can help increase the number of volunteer gleaners. Also, logistics support such as trucks and truck drivers are necessary for increasing processing capacity.

[1] Note that although there are many important activities that food assistance programs engage in, our focus is on gleaning operations. Gleaning operations are typically managed separately from other activities in food banks. In particular, the pool of gleaning volunteers is not the same as the pool of volunteers contributing to other food bank activities (Knowles, 2016). Thus, we define the scope of our analysis to the gleaning operation to match the managerial scope in practice.