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Development of experimental design for the evaluation of food aid packaging

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Abstract

This paper documents the motivation and methodology developed to evaluate the cost effectiveness and potential improvements for the transportation and storage of food aid commodities. Additionally, preliminary fieldwork conducted to map out the domestic portions of the supply chain is also presented. We hypothesize that modern bag technologies, such as hermetic bags, offer the potential to cost effectively improve the quality of food aid commodities as a substitute to current fumigation processes. A range of packaging (current and new), shipping modes, commodities, and foreign ports will be evaluated in the traditional supply chain with the use of a factorial design. Furthermore, the down-stream supply chain portions such as storage will be simulated by placement in repositioning warehouses in foreign ports for up to three months. The use of a factorial design with sliding levels is a crucial method utilized to accommodate the various factors involved in the complex supply chain of food aid. Domestic fieldwork has provided valuable insights into the viability of implementing modern bagging technologies in the existing supply chain.

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1. Introduction

The Comprehensive Initiative on Technology Evaluation is a United States Agency for International Development funded research group housed at the Massachusetts Institute of Technology. In conjunction with partners, CITE conducts technology evaluations and develops rigorous methodologies to evaluate products utilized in the developing world. The partner for this evaluation is USAID Food for Peace, designated by the Agricultural Act or Farm Bill to provide both emergency and non-emergency food aid.

Nomenclature

CITE	Comprehensive Initiative on Technology Evaluation
EA	Environmental Assessment
EPA	Environmental Protection Agency
FFP	Food for Peace
FY	Fiscal Year
GAO	Government Accountability Office
MT	Metric Tons
MIT	Massachusetts Institute of Technology
MWP	Multivall Paper

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PEA	Programmatic Environmental Assessment
PREPO	Prepositioning
PVO	Partner Voluntary Organization
US	United States
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WPP	Woven Polypropylene

1.1. Food for Peace

Food for Peace began in 1954 and is implemented by USAID. The Agricultural Act of 2014 (2014 Farm Bill) reauthorized most of the major international food aid programs, including Food for Peace, through FY2018. Food aid assistance annually accounts for about 4% of total US foreign aid. Average annual spending on international food aid programs between FY2006 and FY2013 amounted to \$2.5 billion; Food for Peace activities (“Title II Food Aid”) accounted for about 80% of that annual budget [1]. In FY2014 alone, \$2.4 billion dollars was spent by FFP to provide a total of 1,360,577 MT of Title II Food Aid to beneficiaries throughout the world [2]. However, commodity and associated costs for delivering food has increased leading to a decline in the quantity of food aid delivered. In 2006 one MT ton of food was \$788 while in 2013 it was \$1,214. This increase in price changed programmed commodity volume from 2,390,000 MT to a total of 1,100,000 MT in FY2013 [3].

1.2. Prepositioning in Food Aid

In order to preposition food aid commodities, USAID orders food aid before it is requested and stores it in domestic or foreign warehouses. This enables rapid response to emergencies, since non-emergency programming of food aid can have a lead time of many months. A study conducted by the Government Accountability Office found that prepositioning food aid reduced the delivery time by up to two months [4]. The 2014 Farm Bill reauthorized prepositioning of commodities overseas, and increased its annual funding from \$10,000,000 to \$15,000,000 [1]. Additionally, the bill granted USAID discretion regarding establishment of additional facilities [1]. The increase of emergency programming from 25% to almost 75% of total FFP allocation in just a decade demonstrates the need to be able to effectively preposition food [1]. More cost effective packaging might allow USAID to increase prepositioning and deliver more food aid.

1.3. Quality in Food Aid

Recent GAO and Tufts Friedman School studies have shown the need for maintaining nutritional quality and safety standards in food aid [5], [6]. Among other obligations, 2014 Farm Bill requires USAID to assess and improve quality (such as nutritional content) of food aid commodities[1]. While the GAO and Friedman recommendations focused mostly on the nutritional content of procured food products, the Friedman report identifies packaging and storage of products to be a key improvement for ensuring quality of food for the beneficiaries [6].

1.4. Fumigation

All fumigants are toxic substances classified by the EPA as restricted use pesticides [7]. Fumigation is applied as a method of insect and/or rodent infestation prevention or infestation treatment. It is administered in the form of a gas to a sealed quantity of grain. Factors affecting effectiveness of fumigation include but are not limited to: the type of grain, moisture content of the grain, ambient temperature, and storage structure [7],[8]. The multitude of factors and difficulty in accounting for them to adjust the treatment highlight the challenges of proper fumigation.

Aside from the benefits of preventing or eliminating infestation from rodents or insects, there can be negative consequences in applying fumigation. The use of fumigants poses concerns related to safety, application difficulty, and/or cost [9]. For example, the use of methyl bromide is being reduced due to concerns related to ozone layer depletion [10]. Aluminum phosphide is the most common form of phosphine fumigation used in practice today. The use of phosphine also has environmental implications at the domestic and the international points of application. Fumigation can impact local air and water quality, which in turn impacts the health of warehouse and port workers, residents near warehouses and ports, and surrounding ecology [9]. Over-fumigation or improper fumigation can also expose beneficiaries to residual fumigants or even contribute to the increased resistance to fumigants [11]–[13]. At the same time, under or improper fumigation can expose beneficiaries to infested grain. Historically, under-fumigation or poor fumigation practices have forced FFP and PVOs to destroy hundreds of metric tons of rotten grain [9]. While fumigation can reduce the rate of infestation it does not control the growth mold, another quality concern related to food aid [9].

All USAID project activities are assessed through an Initial Environmental Examination (IEE), and any activities requiring fumigants are assessed through a Pesticide Evaluation Report and Safe Use Action Plan (PERSUAP). Even so, there is concern whether the IEE and PERSUAP are thorough and rigorous [9]. The Federal Insecticide, Fungicide, and Rodenticide Act

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