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Article

Continuity of Business Plans for Animal Disease Outbreaks: Using a Logic Model Approach to Protect Animal Health, Public Health, and Our Food Supply

Kiana Moore * and Heather Allen

Logistics Management Institute (LMI), McLean, VA 22102, USA; E-Mail: hallen@lmi.org

* Author to whom correspondence should be addressed; E-Mail: kmoore@lmi.org;
Tel.: +1-703-917-7209; Fax: +1-703-917-7517.

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Abstract: Foreign animal diseases can have a devastating impact on the American economy and agriculture system, while significantly disrupting the food supply chain, and affecting animal health and public health. Continuity of business during an animal disease outbreak aims to mitigate these agriculture-related losses by facilitating normal business operations through the managed movement of non-infected animals and non-contaminated animal products. During a foreign animal disease outbreak, there are competing objectives of trying to control and contain the outbreak while allowing non-infected premises to continue normal business operations to the greatest extent possible. Using a logic model approach, this article discusses the importance of continuity of business planning during an animal disease outbreak, providing a detailed and transparent theoretical framework for continuity of business planning for animal agriculture stakeholders. The logic model provides a basis for continuity of business planning, which is rapidly gaining focus and interest in the animal emergency management community. This unique logic model offers a framework for effective planning and subsequent evaluation of continuity of business plans and processes, by identifying explicit stakeholders, inputs, and activities, alongside the desired outputs and outcomes of such planning.

Keywords: continuity of business; animal disease outbreak; logic model; food supply; emergency management

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1. Introduction

A foreign animal disease (FAD) outbreak can significantly disrupt the animal agriculture industry. FADs are often called transboundary diseases, and are diseases of "significant economic, trade and/or food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and where control/management, including exclusion, requires cooperation between several countries" [1]. Whether introduced intentionally or accidentally, these biologic agents pose a risk to animal health, and in many cases pose a serious threat to the economy, public health, and food safety and security [2,3]. Lessons learned from past outbreaks and exercises have demonstrated the need to focus on business continuity for non-infected premises and animals and non-contaminated animal products. Continuity of business (COB) planning can help to mitigate the consequences of animal disease outbreaks by managing non-infected premises and animals and non-contaminated products that are located in regulatory control areas to ensure these entities are not unnecessarily impacted by a FAD outbreak. COB activities promote agricultural economic stability, secure the food supply, and protect animal health and public health.

Our objective is to provide a model which ties the activities and inputs of COB planning directly to intended outputs and outcomes. The logic model approach offers an evaluation-based and outcome-oriented perspective to help emergency planners ensure that COB processes are achieving their intended objectives and to offer a usable theoretical framework for those interested in developing COB plans and processes. A logic model is a planning tool that can be used to graphically display processes or programs, helping to ensure that intended objectives or outputs are achieved by mapping them to inputs and activities. This paper presents the following: (1) information on the impact of an FAD outbreak and the imperative for COB for non-infected premises and animals and non-contaminated animals, (2) an introduction to logic modeling, (3) the theoretical logic model framework and discussion, and (4) steps forward, including the importance of COB planning in improving domestic response policy for animal disease outbreaks.

COB in animal health emergency management is relatively new when compared to COB in other fields such as information technology [4]. The specific objectives of COB in animal health emergency management are the following: to control and contain the disease, to let healthy animals continue to processing and/or market, to ensure animal products are safe to eat (free of disease), and to minimize the disease threat to animals and humans (for zoonotic diseases). In pursuing these objectives, COB helps to defend animal health, support food safety, promote food availability and protect public health [5–7]. There is a wide variety of general guidance available for continuity of operations planning [8]. But in the context of animal health emergency management, COB is just beginning to flourish, and various public-private-academic initiatives are emerging for specific diseases and specific commodities and products. The Secure Egg Supply (www.secureeggsupply.com) [5] and Secure Milk Supply (www.securemilk.org) [6] provide evidence of the success and interest in COB initiatives [5,6,9]. State and regional initiatives are also beginning to form as evidenced by the Secure Milk Supply regional planning [10].

However, a systematic or theoretical approach has not yet been taken to specifically identify what inputs and activities are sufficient or necessary for an effective COB plan, or how stakeholders and activities actually map to or result in the intended output and outcomes. This is why we have selected a logic-model approach, which delineates the stakeholders, inputs, activities, external factors, outputs, and outcomes of a COB plan for an animal disease outbreak. Logic models are used in program evaluation to ensure that programs, plans, and processes result in intended objectives and goals [11]. This type of approach is a framework to ensure that the activities being conducted are effectively creating the desired outcomes. Because COB planning is relatively new, this approach is appropriate to assist in the development of new COB plans, policy, and initiatives, to identify problematic factors in COB planning, to encourage transparent plans for all stakeholders, and to evaluate the effectiveness of existing plans. This type of theoretical model can help improve COB plans and response policy for animal disease outbreaks.

This article is based with the United States in mind, specifically in regard to the risk presented by FADs and the potential implications of an outbreak in the United States. However, the principles and logic-model provided in this paper are likely applicable to a wider context, and could easily be adapted for other types of threats (such as food contaminants), natural disasters, as well as to other countries with similar veterinary infrastructures. This model should be considered a flexible framework based on outcomes, which can be iteratively improved as we continue to learn how to make our COB planning efforts more effective.

2. Imperative for Continuity of Business Planning: Impact of a Foreign Animal Disease Outbreak

FAD outbreaks can have a devastating impact on the United States economy [12]. A highly contagious disease outbreak could severely disrupt the food supply chain and halt the international trade of affected commodities, significantly disrupting the livelihoods of many Americans. Because the United States has for decades been free of many diseases (such as classical swine fever and foot-and-mouth disease [FMD]), its animals are susceptible, as there is no routine vaccination or disease-induced immune response. Responders and officials have also had limited opportunities (typically either exercises or foreign deployments) to practice reacting and responding to such events. Travel and trade, to and from countries with less developed veterinary infrastructure, also increases the risk of an FAD introduction.

In an FAD outbreak in the United States, the goal is to control, contain, and ultimately eradicate the FAD. While states have the primary responsibility to respond to any emergency, the federal government may intervene depending on the scope of the outbreak and regulatory authorities. According to the Animal Health Protection Act—which is the statutory authority for FAD control and eradication—the "Secretary [of Agriculture] may carry out operations and measures to detect, control, or eradicate any pest or disease of livestock" and "may promulgate such regulations, and issue such orders, as the Secretary determines necessary to carry out this chapter" [13]. To stop the spread of the FAD, disease transmission must be rapidly controlled [14]. As such, the movement of animals, animal products, and conveyances must be restricted—sometimes significantly, particularly as the extent of the outbreak is being assessed. These restrictions on movement are typically in the form of quarantines, hold orders, or other permitting requirements under the legal authority of the state or federal government [15,16].

Some, however, argue that the goal should not be eradication of the disease no matter what, but rather "market survival" [14]. So, while the intention of these movement restrictions and quarantines are certainly to halt the spread of the disease, the scope of these activities frequently impacts not only infected and directly affected animals, products, and conveyances, but also those animals, products, and conveyances that are non-infected and non-contaminated, such as those that may be in close geographical proximity or within the same disease control area [7,9]. For large FAD outbreaks, or for even small or moderately sized outbreaks in areas where there are dense populations of production livestock, these movement restrictions can cause major disruptions in supply chains and marketing patterns. An FAD outbreak also has implications for international trade. Importing countries typically ban affected imports during an FAD outbreak. This paper specifically focuses not on exports and international trade, but intra and interstate trade in the United States. However, we acknowledge that many of the practices discussed here may also improve the likelihood of rapid reestablishment of international exports through regionalization or other means.

For example, products—such as raw milk or eggs—often may need to move off a production premises at regular and frequent intervals, particularly if the production facility is vertically integrated (and the products need to move to processing). So depending on the length and scope of the movement restrictions, products may not be able to move, forcing unnecessary disposal of non-contaminated products. When many non-infected premises are impacted by the quarantine and movement restrictions of an FAD response effort, the amount of product that is forced into disposal channels may be quite significant. Ultimately, the market for these products and subsequently the food supply may be impacted. The objective of COB is to keep these animals and products from non-infected premises moving to mitigate the disruptions to the food supply.

However, moving products during an FAD outbreak from premises, believed not to be infected, carries some level of risk that the premises could in fact be infected—albeit undetected [17]. This could result in moving FAD-contaminated products off the premises, threatening not only animal health, but in cases of zoonotic diseases, public health as well. Other animal herds and flocks could be infected from moving contaminated animals and products; the food supply could be tainted with products containing the biologic agent, possibly posing a threat to public health. While the potential risk of moving certain animals or animal products from non-infected premises may be negligible or low, especially with appropriate testing protocols, biosecurity and cleaning and disinfection mitigations, it is not zero.

COB plans for FAD outbreaks must carefully balance the need to move animals and products for continuous food supply and economic security with the need to protect public health and animal health. As clarified in this article, effective COB plans can be implemented not only to mitigate disruptions to the food supply and security but to actively protect animal health and public health through specific activities discussed below.

Given the risk and potential consequences of FAD outbreaks in the United States, there is a strong imperative for the systematic and wide development of COB plans to allow the movement of animals and products from non-infected premises. The next section details the logic model for COB plans for FAD outbreaks.

3. Logic Modeling

Because logic modeling has not yet been completed on COB planning or programs for FAD outbreaks, we will briefly introduce the purpose and relevance of a logic model. Logic models are frequently used in program evaluation, and widely cited as effective instruments to illustrate, describe, and communicate about a program, including as a tool in performance evaluation, including in epidemiological programs, such as interventions in environment or behavior which are intended to change health outcomes or alter disease incidence rates [11,18]. This type of modeling is frequently described as beneficial for program development and progress and to identify things that are critical to goal attainment. Typically, logic models include components such as inputs (resources), activities, outputs, and outcomes [18]. The logic model links the situation to the intervention (inputs and activities) to the desired outcomes (solution). Often, outcomes are differentiated between short, medium, and long-term to help improve the transparency of the program's objectives to both internal and external stakeholders. Many logic models also incorporate, in some manner, external or environmental factors that may impact the intended effectiveness of the program, such as the political or social activities or phenomena [19,20]. Logic models may also address factors that may specifically facilitate or impede the program's process, such as risk or the innate characteristics of individuals involved.

Logic modeling has been widely used in a variety of emergency preparedness and response contexts, including to assess public health emergency preparedness efforts and disaster recovery practices, as well as to evaluate learning outcomes and management techniques [21–24]. Logic modeling has also been used to advance broader objectives, such as improving human health [19,25]. It is a natural extension to begin using logic models more frequently in animal health emergency preparedness, response, and management activities to improve animal health, public health, and to protect the food supply.

4. Applying Logic Models in Emergency Management

The logic model improves planning during the preparedness, response, and recovery phases of emergency management. Documenting COB plans facilitates transparent planning and improves stakeholder (consumers, trading partners, industry, and regulators) confidence. During the response, the logic model can help with implementing and adjusting the strategy, by providing a list of implementable steps and desired short-term outcomes that should be achieved. Incident Commanders and other response officials may use many of the outputs such as risk assessments, models, and COB plans to advise the response strategy. For example, risk assessments developed prior to an outbreak may demonstrate there is negligible risk of disease transmission when moving certain commodities. The Incident Command may allow animals and products with negligible risk of disease transmission to continue to move through the food supply chain. Logic models are also a tool for evaluating the response, after an incident. Planners can use the list of outcomes to map the successes of the response and identify lessons-learned.

5. Logic Model for Continuity of Business Planning for Animal Disease Outbreaks

Table 1 lists the components of a logic model for COB for FAD outbreaks. Appendix 1 contains a graphical representation of the logic model components. The components in Table 1, grouped by stakeholders, inputs, activities, outputs, short- and long-term outcomes, and socio-political-economic-environment factors, are the major components required for successful COB planning. This model was developed based on three sources of information: first, the authors own experience in COB planning at the federal level, second, the input of stakeholders and subject matter experts involved in COB planning, and third, the review of peer-reviewed literature on the development of effective emergency plans and processes. We would like to stress that this model is a general framework, illustrating the process of COB planning with the general components involved and frequently desired outcomes.

This theoretical model provides transparency for all stakeholders into the workings of COB planning, clarity in both short- and long-term objectives, and an opportunity for those involved to more accurately evaluate the effectiveness of COB objectives during and after an FAD outbreak. The model can be used to (1) assist in the development of COB plans, policy, and initiatives by outlining goals and objectives, (2) identify problematic factors that need to be considered in COB planning, (3) encourage transparency in plans so they can be communicated effectively to all stakeholders, (4) evaluate the effectiveness of existing plans, and (5) improve COB plans and response strategies for FAD outbreaks. Connecting the problem to the desired outcome through intermediary steps, this program-oriented approach can enable more effective and resource-efficient planning, execution, and assessment of COB plans to improve response policy.

This section discusses the components and external factors in the logic model. The components are first discussed theoretically—this model provides examples that are specific to COB planning, but very broad. Section 5.7 offers more concrete examples of implementing this model. Each of the model's components would be tailored specifically to the commodity, movement type, and risk of movement. The purpose of this model is not to tell emergency planners what their outcomes should be, but to offer a framework in which they can put their inputs, activities, and outputs in to, thereby understanding the interaction between what they do on a day-to-day basis, and what they would like to achieve in the long-term, with respect to COB initiatives.

Table 1. Logic model components and factors for continuity of business for foreign animal disease outbreaks.

Stakeholders	Inputs	Activities	Outputs	Short-Term Outcomes	Long-Term Outcomes	Socio-Political-Economic Environment Factors
-Industry	- Identification of Problem	-Formal, Routine Collaboration on Emergency Management Issues	-Risk Assessments	-Consumer Confidence in Industry	-Improved Economic Security	-Science and Risk-Based Policy
-Government	- Known Vulnerabilities to Producers & Processors	-Research, Modeling, and Risk-Analyses	-Transparent Continuity of Business Planning	-Improved Producer Business Practices	-Improved Animal Health Outcomes 1.Herd/Flock Health 2.Lower Risk of Disease Spread	-Political/Regulatory Climate
-Extension and Academia	-Identified Critical Gaps in Planning/Policy	-Writing and Development of Emergency Preparedness and Response Plans	-Improved Understanding of Impacts of Outbreaks on Industry & Consumers	-Emergency Management Policy and Regulation	-Improved Public Health Outcomes 1.Psychological 2.Food Safety	-Consumer Preferences
	-National Security Threats (Economic & Physical)	-Stakeholder Outreach and PR on Preparedness Efforts	-Continuity of Business Plans for: 1.Disease Free Products 2.Lower Risk of Disease Transmission 3.Movement of Products in an Outbreak	-Improved Inter-and Intra-Sector Collaboration	-Food Security in a Disease Outbreak/Animal Health Emergency	-International Norms
	-Assessments of Future Trends	-Full-scale & Tabletop Exercises of Emergency Processes & Plans	-Guidance on Biosecurity, Cleaning and Disinfection Procedures	-Consumer Confidence in Regulatory Authority		-Fiscal Austerity
		-Iterative Review and Assessment of Emergency Plans	-Better Disease Transmission Models			

5.1. Stakeholders

The stakeholders are key contributors to COB planning for an FAD outbreak. Each stakeholder listed is an institution or group that has distinct (while not always congruent) preferences, motivations, and objectives. Other categorizations are certainly possible, though the proposed categories appear to be a relatively natural grouping. These stakeholders also exhibit important interactions, as indicated both in practice and in theoretical literature. For example, industry action (and inaction) influences government action and regulation [26,27]. Government regulation also affects human health and consumer behavior [28,29]. Extension and academia can simultaneously be funded by, do research with or for, and collaborate or coordinate with the other two groups. Subsequently, in any COB plan, these three inputs must be considered individually and in terms of their interactions. Regardless of how the stakeholders interact with one another, there are significant organizational challenges in creating COB plans that will ultimately be integrated into new public policy. As with many other public policy reforms, other factors can influence the desired outcomes, including politics, resources, and personal objectives. Therefore, it is often helpful to have a policy champion that can motivate stakeholders, legitimize the need for the policy change, garner critical resources, and mobilize others to contribute [30].

Figures 1–3 show each stakeholder's primary role in the model's activities and outputs. While several of the stakeholders are involved in many of the areas not listed, the authors are identifying the stakeholder(s) that have the primary role in each activity and output. The figures are useful for both the stakeholders involved in developing the plan as well as external stakeholders to ensure transparency in responsibility and accountability for the activities listed.

Industry (see Figure 1) is critically important to any COB plan. In fact, it is often interest from industry that can initiate, facilitate, and/or support a COB plan for a specific animal or animal product [5]. Considering that industry will need to implement the COB plan, their role as a stakeholder is critical to the plan's success. Industries and producers, regardless of size, also hold a wealth of information about the specific procedures and best practices for particular animals or animal products, including considerations for specific disease agents, biosecurity considerations for small and large producers [31], cleaning and disinfection processes, supply chains, and other logistical processes that may be impacted in the event of a disease outbreak.

While industry is a critical component in a COB plan, regulatory partners are also vital. All emergency response efforts start locally but may escalate, depending on the incident, to involve state and federal responders. FAD outbreaks result in intervention by local, state, and/or the federal government, and response operations are in many contexts framed by local, tribal, state, and federal laws and regulations; these include quarantine, disposal, enforcement, and disease reporting [32,33]. In the case of an FAD outbreak you will always have state and to some level federal involvement because of the implications on interstate commerce. The Animal Health Protection Act, in fact, enables the Secretary of Agriculture to prevent, detect, control, and eradicate diseases and pests of animals, including foreign animal and emerging diseases, in order to protect animal health, the health and welfare of people, economic interests of livestock and related industries, the environment, and interstate and foreign commerce in animals and other articles [13]. The private sector, while containing no regulatory power, provides goods, services, and expertise. They typically can provide contracted research and supplemental support for the government. The lead responsibilities of government are shown below in Figure 2.

Figure 1. Industry's lead responsibilities in continuity of business.

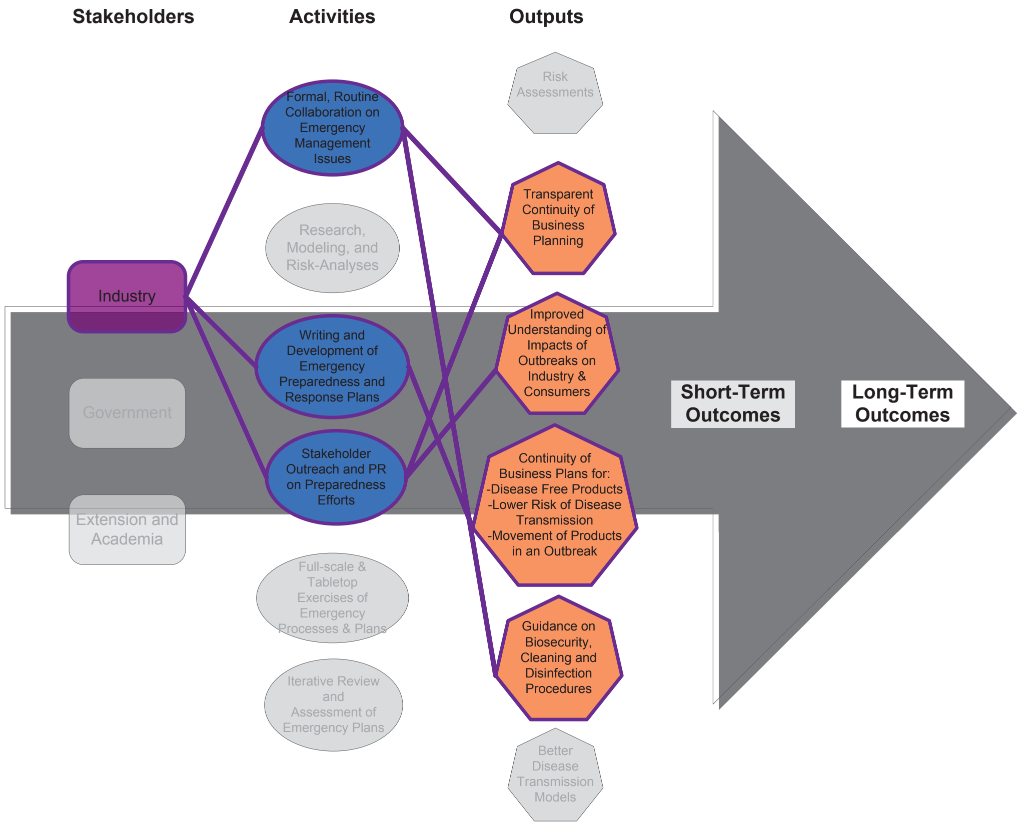


Figure 2. Government's lead responsibilities in continuity of business.

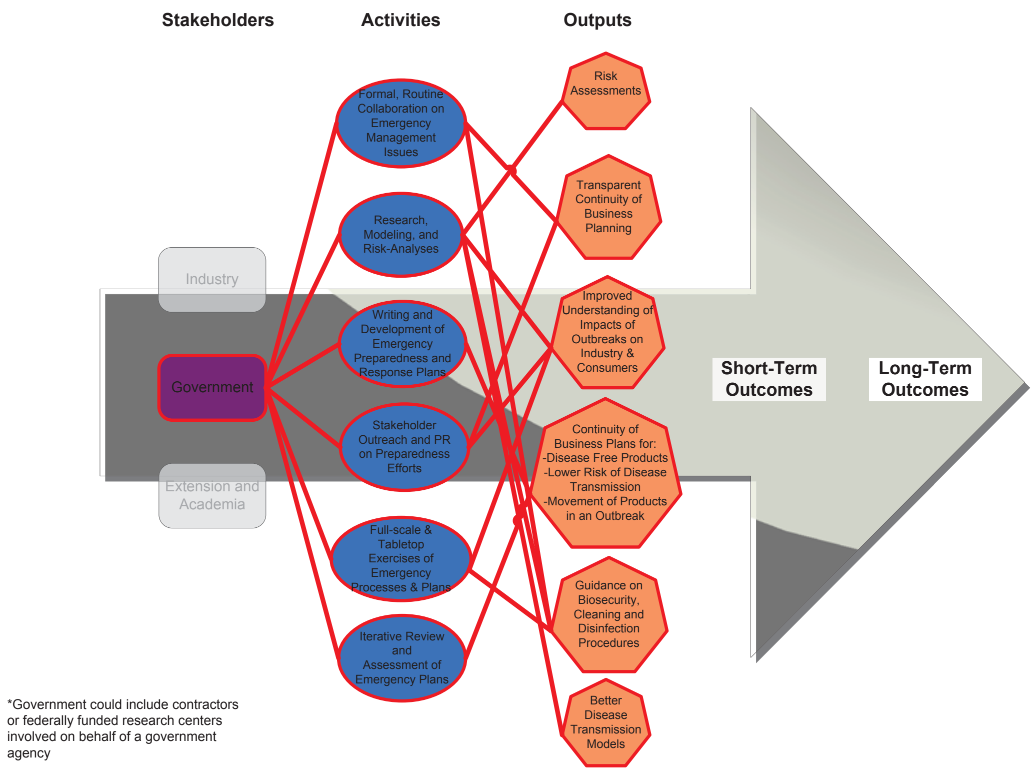
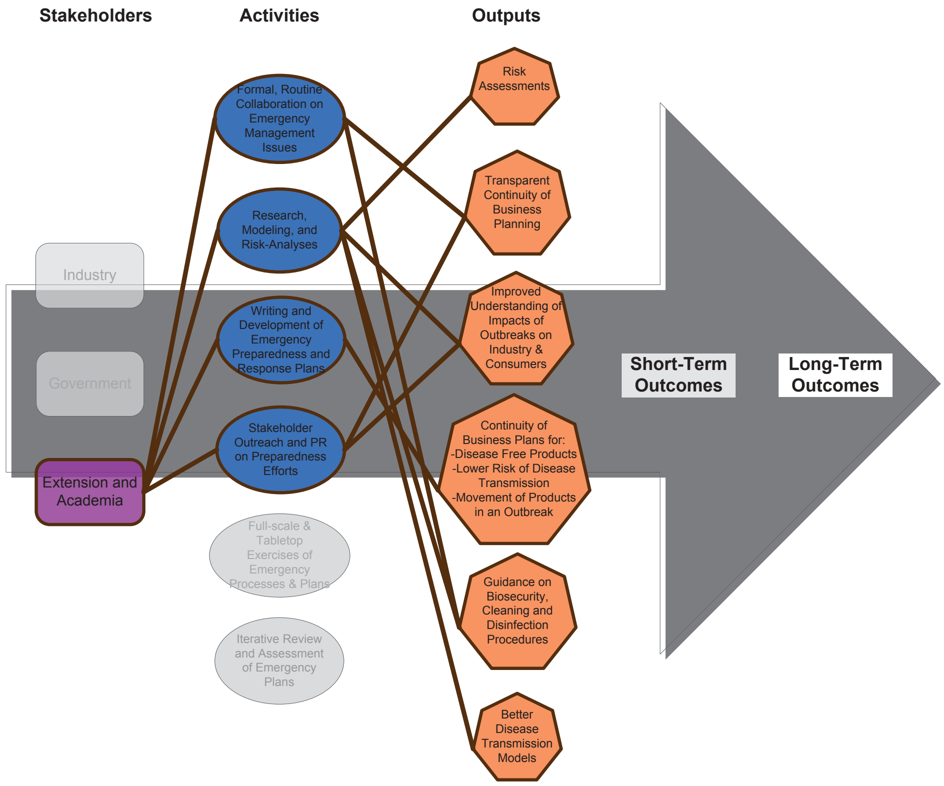


Figure 3. Extension and academia's lead responsibilities in continuity of business.



In addition to industry and regulatory partners, extension and academia also are critical to COB planning. Figure 3 illustrates extension and academia's lead responsibilities. Academia, typically at the behest of or in partnership with the government, can provide specific research, modeling, and assessments on specific measures related to COB plans, whether evaluating the risk of moving a specific product, or primary research on the disease agent or biosecurity measures. In addition, extension can help to facilitate outreach and communication to stakeholders at a local level, including both industry and consumers, particularly those in more rural areas [34]. Academia has already demonstrated its involvement in COB planning through its instrumental work in public-private-academic partnerships to facilitate the writing and conceptualization of COB plans [5,6,9].

5.2. Inputs

After identifying the stakeholders, the next step is to seek out the model inputs. As with the other components of this model, these activities may need to be tailored specifically to the industry, product, or outbreak at hand.

The National Infrastructure Protection Plan requires the food and agriculture sector to assess the risks to the industry as a function of consequence, vulnerability, and threat [35]. This assessment will identify known vulnerabilities, critical gaps, and threats to the nation's food supply. This is not an exhaustive list, but represents several key inputs that should be considered in COB planning.

5.3. Activities

The next step in the logic model is delineating the activities required to create a COB plan for an FAD outbreak. Because of the interaction between the stakeholders, as well as their important independent role in developing and implementing a COB plan, systematic and consistent collaboration between the stakeholders is critical and may be conducted through routine meetings, teleconferences, or webinars involving all of the stakeholder groups [9]. Because of the stakeholder groups in this logic model, collaboration may be characterized as a public-private partnership, depending on the relationships between the stakeholders in the program [36].

The government conducts primary and applied scientific research, modeling, and risk-assessment. Additionally, it often contracts or provides funding to extension and academic groups for such research and analyses, particularly when additional personnel or expertise is needed. These more technical activities form the scientific foundation to support evidence-based programs and policies [37,38]. Modeling can be important to understand the consequences of the introduction of a disease, indicating how fast the disease may spread, or providing evidence of how to detect disease outbreaks more rapidly [39]. Modeling and other types of analyses, including cost-benefit analyses, can also be used to assess the impact of different response strategies on the management of disease outbreaks [40].

Plan development, which include federal, state, industry and site-specific plans, can theoretically be conducted by any of the stakeholders; the level of involvement often depends on the type of plan being developed. Writing—and reaching consensus on the components and details of the plan—can be a difficult and time-consuming process, particularly if the stakeholders have numerous competing interests and priorities. The plan can have many different components, all of which will need to be worked on based on the other activities listed in the logic model. However, it is critically important to formally document the COB plan for transparency and consensus, and to use in an emergency [41,42]. For example, COB plans may contain guidance and directives on biosecurity, cleaning and disinfection procedures, diagnostic testing and/or surveillance requirements, and movement controls or permitting processes for non-infected premises [5,6]. The specific components and the nature of the components in a COB plan are likely to be specific to the product or products in question as well as to the nature of the disease agent and the risk posed to both animal health and public health. When performed nearly simultaneously to the development of the plan, outreach can ensure that external stakeholders feel included in the process, and may become less leery of the final product. In addition, in the event that the COB plan becomes integrated into regulatory policy or policy guidance, this incorporation of and outreach to the stakeholders may encourage support.

Without a doubt, there are many important activities that fall within the broad activities listed in Table 1. For example, site visits to better understand production processes may be required to conduct risk assessments. The development of the plan may need to not only involve regulators, but also those familiar with international standards and state law, to ensure COB plans consider the legal frameworks at the international, state, and national level. Other activities may include socializing the plans at conferences and other symposiums. This model is not meant to list every element involved in COB planning; it is meant to be a framework and lay the foundation for planning efforts.

5.4. Outputs

The fourth step in the logic model is identifying outputs, listed in Table 1 and depicted in Appendix 1. Outputs directly result from stakeholders conducting activities with specific inputs. For example, risk assessments will be a product of research and modeling on the risk of disease transmission. These risk assessments provide qualitative and/or quantitative evidence regarding the potential for disease spread for a specific movement during an outbreak [43]. Risk assessments are a key source of information for science-based policy decisions.

The writing and development of emergency preparedness and response plans, as part of the COB process, can not only highlight gaps in existing planning which need to be filled, but lead to an improved understanding by all stakeholders regarding the challenges faced by different groups during an outbreak.

As stakeholder outreach occurs during the planning processes, this leads to more transparent COB planning and potentially increased producer and industry knowledge regarding specifics (biosecurity or cleaning and disinfection procedures, for example) that are most important to thwart FAD transmission during an outbreak.

Most importantly, the activities lead to COB plans. These plans provide clear guidance to ensure that products are disease-free, that movement has a low risk of disease transmission to non-infected animals during an outbreak, and that movement of non-contaminated products continues to further processing or market. The activities, in other words, result in a tangible set of guidelines, procedures, or details that can be used by regulators and industry in an FAD outbreak [5,6].

5.5. Short-Term and Long-Term Outcomes

Finally, the ultimate objectives of any COB planning are short-term and long-term outcomes. For example, going through the COB planning processes can mean that producers' business practices are improved as they better understand disease transmission pathways. Furthermore, the process of conducting all of the activities and working together can result in improved inter-sector collaboration. Furthermore, completing COB planning and related activities like outreach and risk-analysis can help improve consumer confidence not only in industry practices, but in the regulatory authority's capacity and capabilities to effectively deal with an FAD outbreak.

Together, these short-term outcomes which are a result of COB planning also result in important long-term outcomes. These long-term outcomes, which are mostly realized in the event that an FAD outbreak occurs, are critically important to public health, animal health, the nation's food supply, and the economy [44]. Successful COB planning will ensure a continuous flow of non-contaminated food through the supply chain and reduced disease transmission. These long-term outcomes provide a clear path for the stakeholders to keep in sight as they collaborate to produce COB plans, and clear objectives to keep in mind when designing specific criteria or communicating to the public or other parties. These long-term outcomes are the fundamental backbone of why COB planning is important for the United States in FAD preparedness and response planning.

5.6. External Factors

External factors are components that are not actively involved in COB planning but have an impact, five of which are discussed here. Federal, state, tribal, local law, international partners and laws, along with consumers have a direct impact on market continuity and a business' ability to get products to market. Each of these aspects can pose grave economic consequences on the agriculture industry. COB plans must be written in concordance with any relevant laws and regulations.

In agriculture and other policy areas, consumer preferences and behavior impact the animal industry [45,46]. Consumers' and international stakeholders' acceptance of products, and perceptions of risk will influence the demand for products. Moreover, if food products are contaminated with an FAD agent, consumers may adjust their behavior depending on their risk aversion or preferences [47]. It is important to keep consumers informed through outreach and ensure that there are clear expectations and accurate perceptions of risk [48].

5.7. Implementation

This logic model framework offers an implementable way for emergency planners and stakeholders to begin COB planning (or to evaluate current efforts). In each of the categories, using the guidance provided in Table 1, a program manager can develop specific inputs and activities for relevant stakeholders. For example, the stakeholders could include specific commodity groups appropriate to the commodity in question. As part of COB planning efforts, these groups would conduct activities based on the inputs suggested here (or other appropriate inputs, as recognized by a program manager). Inputs may include budgetary restrictions based on a specific contract or cooperative agreement. Activities may be highly specific, such as engaging a specific organization to assess the risk of a proposed commodity in an outbreak situation. The program manager would then identify the specific short-term and long-term outcomes desired by the COB activities performed by the stakeholders. While the outcomes reflected in Table 1 are appropriate for COB planning in general, more specific outcomes may be desired and would typically be useful for later plan evaluation. For example, the following could be a short-term outcome: conduct market research on consumer acceptance of a commodity during an outbreak, and develop appropriate messaging to reflect any concerns from consumers or trading partners. The long-term outcomes may be more intangible or at least more difficult to quantify, but program managers can still create qualitative criteria that can be measured and evaluated. For example, for a specific commodity, a long-term outcome could be: ensure that 50 percent of producers in a state are participating in the COB biosecurity requirements. There may also be specific long-term outcomes related to the high priority FADs, such as: protect public health by ensuring COB plans, including diagnostic testing requirements, are fully implemented and observed in eight of ten participating counties. COB planning, and this framework, is iterative and flexible for an effective FAD response.

6. Discussion

The previous sections have explained how logic modeling can be used to provide clear objectives for emergency preparedness and response planning; they offer a framework for evaluation of planning, and transparently illustrate COB planning processes to stakeholders and other external parties.

Perhaps most notably from this logic model, while many of the long-term outcomes come to fruition during and after an outbreak, the positive short-term outcomes are not reliant on an FAD outbreak actually occurring. The collaboration processes and activities conducted by the stakeholders during COB planning result in positive outcomes regardless of whether an outbreak transpires: for example, there remains improved emergency management policy, potentially improved producer business practices, collaboration and communication both within and between sectors, and increased consumer confidence.

As discussed, this logic model can be further defined to be less abstract, incorporating clear performance measures that are measurable to ensure an appropriate evaluation can be conducted of COB planning after an outbreak. For example, parameters or goals could be set for both the short and long-term outcomes. Such parameters may be difficult to establish prior to an outbreak, and will require flexibility and adaptation in an outbreak situation. However, such work is important to demonstrate more objective effectiveness of COB plans and programs. As we gain more experience in executing COB plans during FAD outbreaks, emergency managers will become better at setting appropriate criteria for the short-term and long-term objectives, emphasizing program effectiveness but avoiding unreasonable expectations.

7. Conclusions

While the United States' just-in-time (JIT) food distribution model is extremely effective, it also has key vulnerabilities. JIT techniques keep cost low by eliminating storage costs, requiring grocery stores to only keep enough food on hand to last until their next shipment. This technique assumes the continuous, uninterrupted flow of goods through the supply chain, starting at the farm. Any disruption, such as movement restrictions because of an FAD outbreak, could cause significant disruptions to this JIT system, costing producers, consumers, and everyone in between. COB planning is particularly critical in industries that use the JIT model, because stopping the movement of animals or animal products for even less than a week could result in serious economic consequences.

COB planning reduces the risk of disease transmission while allowing disease free products to travel to further processing or market, reducing potential disruptions in the food supply. Work on COB is relatively new, with a renewed focus on managing non-infected animals and non-contaminated animal products during an outbreak, while simultaneously controlling and containing the FAD agent. COB planning helps to mitigate losses, facilitate a continuous supply of food, and allow agriculture and food industries to maintain operations by minimizing the impacts of quarantines on non-infected premises within regulatory CAs. While much work has been completed on actual COB plans, a theoretical or program-evaluation approach has not been applied to COB planning for an FAD outbreak. This article presents a framework that can be used to design, describe, communicate, and evaluate COB planning. In the future, this process-oriented model can be tailored to specific situations, and altered as needed by a particular COB plan or program. It can also be used to provide transparent criteria to formally evaluate the effectiveness of COB plans in real events or full scale exercises.

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Appendix 1