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FOOD TRACEABILITY DESIGNED FOR DEVELOPING COUNTRIES

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The United States and Europe import cocoa, coffee, pineapples, and other agriculture products from farms in developing countries. Imported crops especially fresh, uncooked produce need to be traceable to the farm site origin, in the event of a pest infestation, a bacterial contamination, or some other food safety issue. Government regulators must quickly identify the original source when a food-borne illness has occurred. Food safety and overall production quality require a food traceability system.

The OASIS Information System (in operation since 2014) has been used by private farms and a government agency in Ghana and Kenya. The food traceability part of this system corrects a design flaw found in other systems, meets an international standard, and implements an adaptable and more secure barcode symbol. A farmer would only need an Android smartphone to create traceability farm codes and manage and report farming activities.

Design Flaw in Food Traceability

Most food traceability systems are designed from the perspective of a processing factory or a production facility that operates after the harvesting stage. The incoming crops are grouped into a production batch and assigned an identification number. The unique identifier would typically be in the form of a Universal Product Code (UPC) barcode symbol. When a food-borne illness has occurred, the processed product can be traced not to the farm but to the post-harvest facility.

Not all farmers send their crop harvest to a post-harvest production facility. Many small-

scale farmers would transport crates directly to local markets. Large-scale producers in Latin America and West Africa would ship pallets of stacked boxes directly to international distributors that would then forward the perishable food shipments to retailers. Without adequate tracking of the fresh crops, it can be difficult to trace a food safety issue back to the farm site. Insufficient safeguards and controls regarding phytosanitary measures became a problem for Ghana when the European Union had imposed a ban on specific Ghanaian vegetables in 2015 and 2016.

A new food traceability system had to be designed that would better match the farmers' situation.

Guiding Principle in Food Traceability

The International Organization for Standardization (ISO) provides guidance in how a food traceability system should be designed. ISO 22005:2007 lays out the requirements and describes that a "traceability system should be able to document the history of a product and/or locate a product in a sequence of stages and operations involved in the production, processing, distribution, and handling of feed and food, from primary production [the farm site] to consumption." Note that this international standard only covers food traceability, which is one part of a food safety program. A complete food safety management system must follow the requirements in ISO 22000:2018.

Barcode Symbol in Food Traceability

The conventional UPC barcode symbol would not be adaptable to a wide range of farms in multiple countries. This one-dimensional symbol is limited in capacity, storing up to 12

numbers. Farmers may have their own naming convention when they define identification names. Thus, another symbol technology that is flexible would be a better option.

Two-dimensional barcode symbols such as a Quick Response (QR) code can store more characters that may include both letters and numbers. Unicode characters may be stored as well. The QR code provides for a higher degree of security, as the unique identifier does not need to be visible in plain text and instead can be completely encoded in the generated symbol. The QR code can also be scaled down to 0.10 inches by 0.10 inches – small enough to be able to track a loose bundle of string beans.

Management Information System for Food Traceability

The Web application component of the OASIS Information System, which is developed in ASP.NET MVC, provides the engine for generating and storing QR codes and managing associated records. The farmer can define their own unique identification name, which will be encoded in a unique QR code symbol, for each farm field. Details related to the farmer's activities such as chemical applications, soil samples, and crop harvests are associated with the saved QR code. User access rules apply to restrict who can generate the QR code, download it for printing, and review information records. The private mobile app component, which runs in an Android smartphone or mobile tablet, provides the front-end user interface for the farmer to create and download QR codes for all farm fields under management. The public mobile app component allows buyers and consumers to scan the QR code printed on the farmer's packaging to reveal the farm name, the specific farm field, the crop variety name, village, and country of origin, the complete identification of which will meet a major requirement for GLOBALG.A.P. certification.