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Designing a Conceptual Production Focused and Learning Oriented Food Traceability System

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This paper introduces the architecture, operational and organizational structure of a conceptual food traceability system, which facilitates farmer and producer participation into food safety enforced legally by EU and many countries worldwide. Contrary to the existing traditional ERP-integrated traceability systems, proposed conceptual system (c-Trace) suggests a new approach that will combine traceability, informing and learning together since it will be able to provide the required information and learning resources on the food safety standards and application methods such as EUREPGAP and HACCP during on-line data entry into the system. Therefore, our conceptual system will serve as a traceability platform that focuses on primary production and learning with the support of on-line screen tips and relevant learning pages. Since the chain stakeholders and consumers will be able to query the produces sold in the markets via Web-, WAP- and/or SMS-based user interfaces c-Trace also provides a desirable transparent traceability for all parties in a food chain at the same time by querying producers- and production-related information by consumer directly. The system aims at assisting the transformation of many small and highly fragmented farms from traditional to sustainable agriculture through its architecture that providing relevant applicable information on good agricultural practices and traceability regulations while they record their production details into the system.

Index Terms—**agriculture, food safety, food traceability, traceability systems**

I. Introduction

CONSUMER sensitivities on food safety and quality has increased in developed countries particularly in Europe since food based serious health problems and deaths, food based threats and potential health risks reported during the last 30 years has led to a great trust lost of consumers. Consequently, demand and expectations for a safe and high quality food system by consumers have forced governments to take some action measures and issue some regulations to ensure food safety and security. Probably the best known of food safety regulations is the European Union Food Safety Law numbered EC 178/2002 [5]. Furthermore the events of Sept. 11, 2001 reinforced the need to enhance the security in the United States (US). US Congress responded by passing the "Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (also known as the Bioterrorism Act shortly)" [17]. The Title 3 of Bioterrorism Act regulates "Safety of Food and Drug Supply" including registration and records keeping for traceability. Among other countries, Japanese Government enacted Food Safety Basic Law in May, 2003 [18], and the Law of Traceability for Agricultural Products was put into operation in August, 2005 in Korea [19]. Like many countries in the world, Turkey also has ensured food safety by enforcing Law 5179, titled as "Law of adoption of the amended decree by-law on the production, consumption and inspection of foods" in 2004 with compatibility aim to EC 178/2002 [3].

In the Article 3 of EU General Food Law, "traceability" is defined as "*the ability to trace and follow a food, feed, food producing animal or substance through all stages of production and distribution food, up to and including its sale or supply to the final consumer and, where relevant to food safety, the production, manufacture and distribution of feed*". The Article 2 of same law enforces that farms to incorporate a traceability system by defining food business as "*any undertaking, whether for profit or not and whether public or private, carrying out any of the activities related to any stage of production, processing and distribution of food*".

According to the definitions, traceability begins with primary production stage in farms. Therefore, the farmers are also obliged to record inputs of all fertilizer, pesticides, seeds, seedlings, saplings, hatchery, breeding animals and/or livestock etc whatever they use or apply in their production. They are also responsible to present all those record to competent authorities for inspection when required. In general, the above mentioned laws enforce producer responsibility to the identification of the suppliers of all inputs and buyers of products to setup one step up and one step down traceability.

Traceability is recognised as a key system with regard to incidents and alerts [21]. In the food safety regulations, traceability is considered as a system targeting the collection of information and documents related to inputs used and the products obtained within the production process. Regulations and related codes, which are issued to clarify implementation details of the laws, set out the details of risk and crisis management together with some other details. To conclude, laws related to food safety aims to find out the source of the problem in case of any incident/disaster and to ensure related solution of some crisis management issues, firstly recalling. Furthermore, in any critical situation, a downstream to upstream tracing logic has been given preference while a reverse inspection is necessary in order to activate call-back mechanism [2]. In a sense, for the most of laws this kind of one step traceability approach, which can be called as "traceability at basic level", a vital tool in food safety and aims to ensure safe delivery of the foods to consumers.

Beyond ensuring food safety and security, traceability is also concerned to establish sustainable production in agriculture, physical security and brand/market protection [20]. From the sustainability view of point, it is aimed that agricultural production at the primary stage of the food chain, should be implemented in a sustainable way in the framework of social, humanitarian and conscious responsibilities, through methods and techniques minimizing possible damages to the nature and through ecological and environmentalist approaches [3]. Even more, after shifting the course of the her Common Agricultural Policy (CAP) applied since 1958 towards a completely different direction, European Union aims to restructure agricultural production by adopting following policies: improving food quality, developing sustainable production while developing rural economies, rational and saving natural resource use, preventing environmental pollution, and protection of biodiversity and traditional and natural landscape [10, 11].

Consequently, in order to create a basis for the solution of all those problems as a whole, some new technique and methods (such as integrated farm management and good agricultural practices) are being developed and implemented. To conclude, there is a need for solutions on a sustainable agriculture, environment and life, balancing comments and demands of all parties involved, including particularly businesses taking part in food chains such as farmers, food industries, distributors and retailers together with non-governmental organizations, government and consumers. Unfortunately, this requirement mostly ends up with opposing opinions in a rather complex food chain, especially for farmers, even traceability should be seen as a complement or as an integrate component of quality assurance systems [22]. The CAP, policies and principles applied accordingly, production standards such as EUREPGAP, presence of international food quality and safety standards such as HACCP, ISO 22000 etc., and retailer demands towards such standards. The traceability is being played a role as an efficient tool in ensuring these standards.

Although establishing traceability systems has been demanded by consumers and enforced by the laws due to reasons explained above it does not function properly. Especially, at the farm level of traceability there are some sector specific problems to overcome. Firstly, in this new age of agricultural production, it is required that farmers be informed on new developments, laws, policies, standards, applications, techniques and methods, be trained and be organized for alternative production methods and systems. Because in some EU countries (i.e. Hungary, Greece, Romania as well as Turkey) the farms are mostly small sized and fragmented, and they do not have economic power sufficient to apply new developments in agriculture. Hence, while losing government subsidy and incentives, today producers has come under pressure of transition to a new agricultural production system which they do not know and are not familiar. As stated in some work, it is really difficult for small and unorganized farms to establish a traceability system, due to technological, economical, and demographical reasons [9]. In fact, the major difficulty in the establishment of traceability systems is recording primary production information at farms [8]. For example, even in Japan, a developed country it was reported that traceability system is not working enough mainly in the producer step [18]. In Korea, the traceability system is beset with low level of recording due to old age of farmers and relatively small scale farm production [19]. Therefore, they should be helped to establish some system and applications, which they cannot afford on their own or through their unions with limited resources.

Promotion and implementation of food traceability along the food chain is seen as the most important tools for ensuring food safety and quality in these legal regulations. Generally the governments apply a policy promoting construction of food traceability in food processor/operators level. For instance, UK FSA Traceability Report underlines that “The development of ERP systems to deliver both forwards and backwards traceability as a key outcome is on-going” for the food business [21]. This policy loads much responsibility to the food operators of the chain and mostly cannot guarantee the full traceability in real time when a disaster occurred. Encompassing the whole chain should be aimed in the development of an ideal traceability system as stated in many works and reports. This approach is contrary to the widespread institutional and/or sector specific ERP-integrated traditional traceability specialized mostly for the food industry aiming one step forward (tracking) and one step backward traceability (tracing). For this reason, the main underlying principles in an ideal traceability should be the recognition of the assistance requirement of the poorly educated and low income producer domain [12], and this cannot be easily provided with ERP-based systems. In this case, development of primary production focused central traceability systems is a key factor in order to enlarge and ease participation to the system at the first stage of chain.

In this study we introduce the architecture and operational details of a production focused and learning oriented conceptual traceability system. Since our conceptual traceability system (called c-Trace hereafter) discussed in this paper introduces general approaches applicable or modifiable to all agricultural products, our purpose is to present the framework of such a traceability which will be designed as a production focused and learning oriented traceability system but not mainly discuss a traceability schema and/or application for a specific product.

II. Type of Traceability Systems

Traceability in food supply chains can range from internal traceability in an individual production plant to traceability in whole or part of the production chains from input supplies to consumer. As it is expressed in Traceback vision [21], the "ideal" traceability should consist of a system which links all food chain players from the producer up to the retailer instead of establishing scattered traceability models. As guessed easily, transferring many small farmers and producers into the traceability system will create transparency for the consumers and competitive advantage to the producer with the information provided on production and processing [1][22]. To this end, for traceability along entire food supply chain

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including farmers, the use of information and communication technologies (ICT) particularly Internet based technologies became one of the major approaches in order to meet supply management requirements [6]. But the use of these systems must be very simple and accessible from anywhere, especially in the fields at farms when look at the matter from farmers end. Therefore, a traceability system covering farmers should offer various forms of user interfaces from Web to WAP/SMS/MMS with cabled or cellular networks.

It is observed that many projects have been realized for traceability. While the most of them are generally complex ERP-based systems there is a little number of projects which have been developed as production focused traceability systems in recent years. Safetrack (http://www.safetrack.co.uk) and Muddyboots (http://www.muddyboots.com) developed in the UK; Agrosafe in Israel (http://www.agrosafe.il) and Seica (http://seica.info) in Japan [7] are the first examples of these types of systems. Genesis, another system developed in Portugal for red meat traceability, has been designed in three modules (producer, processor and distributor modules) to facilitate participation of small farms [8]. But even all these systems consider with data input mobility, flexibility, and transparency they assume that the farmers have knowledge enough to use the system. However, the expectations of farmers regarding traceability aggregated on information needs and simplicity to use at the first according to our initial interviews with citrus growers. Therefore, beyond being very simple to use, a traceability system should also transfer some level of knowledge to the farmers as well as other stakeholders. This means that the traceability systems equipped with learning tools and experiences will provide required information just-in-time online. This kind of learning oriented traceability systems teaches the producers with application related details on EUREPGAP and HACCP standards during data entry with very simple tools.

III. General Architecture of the Conceptual System

The on-farm impact of traceability will differ depending on the origin and design of the traceability system adopted. Producers may face increased regulatory prosecutions, contractual liability and civil claims if a problem is traced-back to the farm [23]. Therefore the architecture of c-Trace targets full chain traceability with a special focus at farm level, the starting point of a food supply chain. The full chain traceability systems have to serve online on the Internet, and should generally be coded with a three tier Web- or sometimes WAP-based architecture. As shown in Fig 1, as a three tier system c-Trace consists of 3 main tiers:

--Database tier

--Business logics (applications) tier

--Client tier

A. Database Tier

Database tier of c-Trace consists of 4 groups of tables:

--Introductory data and records tables

--Transactions tables

--Geographical information tables

--System and users management and support tables.

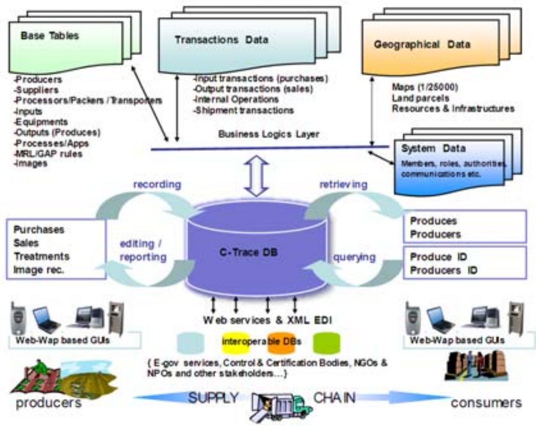

Fig. 1. General architecture of the conceptual system

Base registry data for producers, produces and applications, allowing fast and efficient entry of transaction data should be recorded into registry tables of the system.

In case of the c-Trace, such data include all introductory records on all parties such as producers, suppliers, transporters, processors participated into the system. For an example; a producer information record covers the following fields:

--Producer ID

--Producer name

--Location of the producer (province, district, village, land parcel IDs etc.)

--Producer contact information (postal address, web, e-mail, telephone, fax etc.)

--Producer specific demographic information (education, courses, work experience, labor force etc.)

--Producer specific production information (farm, farmer, product, photos of the fields, orchards etc.)

--Producer specific membership information (Institutions / organizations where the producer subscribed)

--Standards and quality programs applied in the production (ISO, HACCP, EUREPGAP, GMP, GHP, GMP etc.)

--Product IDs for those produced in the farm (product IDs, production areas, and production amounts)

--Other production related details and background information.

With the registry tables, beyond easing transactions processing it will be possible to standardize data uniformity and integrity for all parties along the chain. Database of a traceability system should also have tables containing information on plants/animals produced in farms, inputs and equipments used in production process as well as tables giving information on parties involved [1]. These tables are as follows: Maximum Residue Levels (MRL) table on maximum application levels of pesticides, effect times and application instructions; Good Agricultural Practices tables (GAP), Good Hygiene Applications (GHA) and Good Manufacturing Applications (GMA) are also tables designed to inform producers that will be used in learning process during data entry. Another important informative table taking part in the system is the table of applications and processes. This table supplies detailed information defining proper levels on soil preparation, sowing, planting, pesticide applications, irrigation, harvesting and other applications for each crop. In case of c-Trace the data recorded to these tables will be populated as screen tips box for learning about the standards.

In c-Trace, geographical information tables in the data tier includes maps of the production areas (Google Earth service via mashup methods), topological information, altitudes, gradients, soil type and structure, water resources, and climate and meteorological data. This data is linked with farm location in showing the visual information to the consumers via Internet kiosk in stores, and also beneficial to give information regarding breeding/growing to the producers.

Transaction tables are those tables exposing traceability details on input transactions (purchases), output transactions (sales), shipment transactions (transportation), and containing other records on the processes and applications of the production process in farms or in processing stages. As an example; each record in output-transactions table will consist of the following information:

--Transaction ID
--Sender ID
--Recipient ID
--Invoice ID
--Shipper ID
--Product ID
--Amount of product
--Date of invoice
--Date of transaction
--Dispatch date
--Method of dispatching
--Remarks for output

System management tables are those tables not having any direct relation with the traceability. Those tables are not visible to the users but are constructed for the system management. They include user profiles and roles, system access information (system logs) and also communication information between the members and the management of the system.

B. Business Logics Tier

Business logics layer of the c-Trace system is a collection of modules and stored procedures mainly for input and output transactions. These modules and procedures also generate production reports, lists and statistics when required in addition to basic input and output processes, record, update and delete procedures in the database. Applications and procedures forming the c-Trace business logics tier can be grouped as follows:

1. Data/information processing and exchange subsystem,
2. Searching and reporting subsystem,
3. Learning and informing subsystem,
4. Control lists, reports and statistics generation subsystem.

A great part of the business logics layer is concentrated on input and output transactions during product flow along the chain. Because these business transactions should be controllable and should have determined the links logic interconnecting each stage the product passes. To this end, all input and output entries as well as all agricultural processes and applications should be recorded into the system. All transactions the identity of product must be preserved with traceability codes or linkage of the codes. All procedures implemented at the farm level will be related with each other through unique product codes covering proper combinations of farmer, place, time, and lots variables as will be discussed below *(i.e. producer ID + production year + period + parcel ID + product ID +harvest ID).*

One of the innovative approaches considered in c-Trace system is transparent traceability that helps consumer-choice during shopping. Consumers using the system can access all information on production environment, all applications during all stages (production, storage, processing and distribution) of the product by using a traceability code on the product they purchased in a market, as diagrammed in Fig 2. In this way, a more safe and informative approach will be realized through visual elements (farm, product and even the farmer images) in addition to the textual information related to the producer and product concerned. This should be regarded as an ideal and desired traceability system directly realizing producer-consumer relations, increasing trust of the consumer and providing a competitive advantage to the producer by creating a demand towards his/her safe product.

c-Trace system includes components accomplishing data exchange with other databases. For this purpose, a design recognizing institutional, national and/or international standards and protocols will be implemented. At present, e-Com of GS1 is among the top specifications suggested for the exchange of traceability data.

C. Client Tier

User interfaces consist of many data entry, data update and query forms for tracing and tracking. In an ideal traceability system, WAP and SMS interfaces should also be provided to input and retrieve data through GPRS under field conditions in addition to web based interfaces providing access and visualization to the information through desktops and laptops connected to Internet. Since percentage of people having mobile phone is very high in many countries including developing countries, it is very obvious that how an efficient communication media is provide by SMS- and WAP-based interfaces. Furthermore, systems providing prompt barcode or RFID label reading through Internet kiosks particularly at POS and systems providing manual data entry through web interfaces should be considered.

IV. Design Approaches on Primary Production and Learning Orientation

In our conceptual model, being production focused means that the traceability system should ease data inputs at the farm level. Getting focus on primary production can be gained with following design approaches:

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--Various forms of user interfaces,

--Easing data input with pre-entered item lists on applications/treatments in production at the farm level.

At the farm level, data input should be expected via mobile devices like cellular phones including to Web-based user interfaces. This can be achieved via using WAP interfaces as well as SMS services. Our conceptual traceability assumes that all kinds of user interfaces are presented to the farmers to record inputs, outputs and internal process during production such as fertilizing, irrigation etc.

On the Web-based and/or WAP-based interfaces a user can select the inputs, outputs and production processes from the pre-entered list of these items. It means, for example, a user entering a fertilizer treatment can select this application from an application/process list provided by the system automatically. The other data inputs should be also helped during data entry. For example, the application date can be selected a calendar view instead of entering into the date box. Non-primary production focused systems generally does not provide this kind of facilities to the users. It is a serious lack of many systems because they have mostly been developed for food processors.

In our opinion, an ideal traceability system which is designed to include farmers should offer some learning tools for them, too. Such a kind of system targeting learning as a secondary function can be called as "learning oriented traceability system". In c-Trace, our conceptual system, learning tools are required for:

--Learning how to use the system,

--Learning how internal applications/processes to treat in an appropriate way.

It is very clearly important that learning tools should be provided for the farmers who generally low educated and old people. A learning oriented system can serve learning with how to use guides that have been prepared with interactive and animated techniques. However the existing traceability systems were developed with help component in form of linear textual pages with some images only, c-Trace uses a somewhat different technique for this purpose. We think that calling an animated small learning object for explaining a particular data element during data entry will be more efficient when compared to call a help text.

Secondly, a farmer can learn minimum and maximum permitted values about a production process by seeing these values during data entry automatically. For instance, if a user enters a value over a maximum allowed level in the input box for a specific pesticide application he/she is warned about the allowed levels enforced by the regulations. Another example, while he/she is entering a record on any application he/she is also informed with a small tip box on the screen regarding the appropriate dosage, process, period etc. In addition to informing aid, they are also advised with a short checklist box regarding the processes that will be followed up after it is being recorded. When these summarized tip boxes are clicked the user will reach the learning material related with the subject. The tip panels on the user interfaces will automatically detect user type (stakeholder) and serve the related learning object that is suitable for the user. For example while a farmer can reach GAP and GHP related learning objects and rules tables, a packager will access GMP and GHP tables etc.

As clearly understood from the discussion above, getting a closer focus on primary production and orienting towards learning will ease to use the traceability systems by the farmers who are low educated. Furthermore these approaches will help the farmers to shift the traditional agricultural production, applied mostly through cultural heritage through years, to the new sustainable production systems by learning tools.

V. Operational Model for Conceptual System

A. Activity, Product, Application and Transaction Coding System

Successful operation of a traceability system depends on the right identification of farmers, suppliers, transporters, crops, inputs, equipment and applications according to a proper methodology. Various scenarios can be considered specific to the farmers and product groups. Although specific coding systems to identify the business and products do not create problems for the crops supplied for the domestic markets and in voluntary traceability applications, internationally accepted and applicable coding systems such as GS1 are required for the international markets [24].

In c-Trace all business identities including farms are identified with an alphanumeric coding system composed of province, district, village/quarters, business type and business sequence numbers. In example of c-Trace system this coding system is used for identifying all stakeholders such as farmers, processors, transporters and retailers within the supply chain. For example, TR.01.04.0014.00.00080 code will represent a producer with whose ID is 00080 and locates in village Terliksiz (coded 0014), Karatas district (coded 04) of Adana province (01) in Turkey (TR). In this way of coding system production, processing, distribution and sale locations can be identified uniquely and clearly when a 2 digit number is used for provinces and districts, a four-digit number for villages, a two-digit number for business types (00 for individual farmers, 01 for cooperatives, 03 collectors etc.) and a five digit number for individual farm/firm can be used for identification.

c-Trace uses four types of traceability codes: Input Traceability Code (ITC), Produce Traceability Code (PTC),

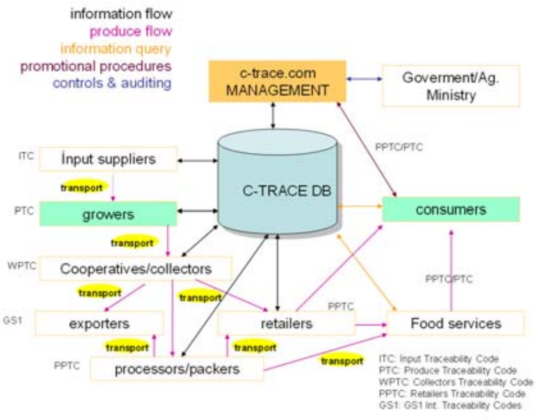

Fig. 2. Product and information flow in the c-Trace system

Collectors/Processor Traceability Code (WPTC), Retails Traceability Code (PPTC). All these codes are created with business ID plus produce code + lot number. For example oranges produced parcel 6 in the farm whose ID TR.01.04.0014.00.00080 and harvested as the third harvest from in December 2007 will have a PPC code like TR.01.04.0014.00.00080-6-01-12/07-3 (lot x). When lot-x is collected by a factory whose ID TR.33.01.0128.03.00125 and mixed with oranges lots from other farms to produce orange juice in December 2007 as the fifth pressing process, the processing factory should built a WPTC like TR.33.01.0128.03.00125-140-12/07-5. All PPCs used in pressing process must be linked with this WPTC as ITCs.

In the examples above, the codes for orange and orange juice are assumed as 01 and 140 respectively. They come from produces tables as explained above in data tier, and formed with c-Trace internal coding system again. However, international compliance can be provided by using North American Industrial Classification System or UN ISIC codes for activity and firm types [16], NAPCS [13] UN CPC, SITC and BEC codes for products, and some other codes such as COFOG, COICOP, COPNI, COPP [15] for transportation etc activities. For this reason a traceability system should have mapping tools between the coding systems effectively. We still working on a such kind mapping for conceptual system.

B. Linking Transactions

Required information in traceability systems are determined by legal regulations, consumer demands, type of product, application details of production and processing [14]. As it is clearly seen in Fig. 2, c-Trace targets recording not only legally required items into the business transaction tables but also all relevant business transactions, starting with production. Because a complete and efficient traceability system can only be accomplished when all relevant processes while product is passing through various stages within the chain. For an efficient information flow, relations and linkages of each step with preceding and following processes is a need to be studied very meticulously. The most critical points, which can destroy traceability, are stages including disassembling, assembling, processing, modifying and packaging. Dynamic lot behaviours in those stages should be modelled with different patterns [4]. Linkage in c-Trace is provided with a coding system similar to the one detailed and proposed for macaroni production in Italy [1].

In the suggested conceptual system, each farm level business transactions was targeted to be monitored by means of a code combination composed of *production_year* + *production_period* + *land_parcel* / *plot_number* + *product_code*. For this reason, all products produced in the farm and sent to the forward stages within the chain will be labelled and registered in the c-Trace outgoing transactions by the farmer and this will be the starting point of the information flow. However, if registration cannot be made at farm for any reason, customer parties such as collectors or cooperatives should register the product into the system on behalf of the producer. To this end, special contracts can be signed between producers and collectors.

C. Responsibilities, Tracing and Recalling

Not only system design but also organization and process management planning is required for a successful traceability. Therefore it is proposed that c-Trace system be operated by an independent but an inter-agency organization under the management and supervision of a committee comprising representatives of the parties involved. Sustainability of the system will be accomplished mainly through the contributions of the parties participated into the system. In such system, registration fees can be determined based on the membership and business transactions. c-Trace management is intended to be responsible for monitoring all new developments in food safety and agricultural production area, particularly those in traceability and for incorporating all these new developments to the new versions of the system.

Registry data of database tier will be entered by c-Trace administration, training will be carried out as blended learning (b-learning) with the members after they receive e-training material and attend face to face training courses.

If a traceability need arises in the system requiring recalling, request will be made through electronic application and c-Trace administration, creating all required tracing reports will immediately inform all relevant parties for recalling and monitor the processes. All these transaction will be recorded to recalling and crisis management tables within the database and will be approved by the parties. As a main principle specified in some studies, recalling tables will be open to access of all parties for their approval, acknowledgement and applications; in other words, it will be ensured that these tables be transparent [10].

VI. Conclusion

Food supply chain management and flow of product information along the chain is increasingly becoming more important for food and agriculture sector. Farmers are the first players in the ‘farm to fork’ traceability to the food chain. In contrary to existing ERP-based traceability systems, suitable for food processors the implementation of traceability schemes may present initial challenges to farmers in order to be able to respond to supplier and consumer demand for enhanced food safety and quality. c-Trace as a conceptual system aims essentially to include farmers into traceability system with its primary production focused aiding tools and learning supports. At present, although c-Trace is at design stage it is planned that the system will be developed and tested in cooperation with the Citrus Growers Association in Cukurova region located in the Mediterranean coastal zone of Turkey, who are more organized and educated producers with a high level of awareness and can use information technologies more consciously. When required project budget is supplied, an action plan for 5 stages will be implemented in 2008:

1. Investigating the structure of the citrus supply chain in the region,
2. Defining applications of a development system, labelling and coding methods,
3. Development of c-Trace software,

4. Modelling traceability management organization and realization of the memberships,

5. Operating the system, implementation of introductory activities and corrective actions.

As a production focused and learning oriented traceability scheme, c-Trace aims at advancing traceability towards an ideal level, besides establishing legally enforced traceability requirements. The advantages which will be created by the system can be stated as follows:

--The system provides a complete and integrated traceability assessing chain as a whole. This is far beyond the legally enforced one step backward and one step forward traceability in the most of regulations.

--Easies participation of poorly educated and low income farmers in the system with learning tools and data entry facilities such as populated boxes with pre-entered values for some farm-level operations.

--Assumes prompt information provision function for producers on techniques, methods and applications envisaged by the standards, laws and regulation with screen tips.

--Provides a point of sale accessible traceability for consumers. In this way, a desired transparency is provided and permanently controlled by consumers. As a result of increasing consumer confidence the traceability offers an added-value with increased amount of products sale. Traceability check during shopping will create both competitiveness and a rational price advantage for the parties involved since consumers would be willing to pay more for quality and safe foods

--Targets a social and cultural integration between producers and consumers, and thus provides a base for rural tourism planned for near future. The geographic information and images can help to create an advertisement effect for attracting the farms and its products.

--Prevents falsification/imitation/fraudulency events since the products can be traced by consumers through Web/WAP/SMS/MMS-based systems on demand. Therefore the traceability system contributes to the protection of the trade mark and product image.

--System allows the generation of information, documents and statistics required by state government institutions and other organizations. Competent authorities and institutions get the relevant report tools for easy observation and inspection opportunities.

--Provides an efficient recalling mechanism because it is near real time traceability system.

--Provides a voluntary readiness for geographic origin, environmental and production traceability, an application though not enforced legally at present, but a possible regulation of the future.

As a final conclusion, it is clear that a high quality supply chain management is very difficult and costly where production is highly fragmented. For this reason, incentives should be provided to encourage vertical and horizontal integration. A good supply chain with traceability features requires investment in human capital, in addition to ICT systems. Furthermore, in this paper we discussed only technical aspects of an ideal traceability system with a special focus on farmers' participation at the same time there is a need to the works on costs and finance models.

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