**BIAS - Blockchain enabled Intelligent Agricultural Services - Project**

The BIAS (Blockchain enabled Intelligent Agricultural Services) project aimed to create a system integrated traceability and certification of the supply chain, based on DLT (Distributed Ledger Technologies) of new generation (e.g., Ethereum blockchain) and Artificial Intelligence of "explainable" type (using "shallow" Artificial Neural Networks). BIAS proposed to monitor and record, in a transparent and immutable way, the quality, origin and the various stages of the supply chain to ensure new levels of food safety and trust, from the field to the final consumer. BIAS is also an anti-counterfeiting tool: the DLT allows, in fact, to associate the product a unique and non-replicable digital identity, which guarantees the authenticity, origin and quality of the products. Following a data-driven approach, BIAS allows to collect and record relevant data for the supply chain control through different methods and from different sources (human interaction, sensors, management tools, etc.), encrypt and share them on the blockchain. During the experimentation phase, the developed platform was tested on 2 use cases: the pilot supply chains of the “Datterino” tomato and the Sardinian spiny artichoke. The platform was hence deployed in real production contexts.

The BIAS platform consists of a few main software components: a middleware, a blockchain and two consultation tools; the first one is for operators in the supply chain and the second one is for consumers.

The middleware is a cloud application that offers the functions necessary to acquire data and documents by storing them in a relational database. It is composed of: Operator input interfaces, Data acquisition interfaces from IoT devices, Data acquisition interfaces from other existing DSS platforms, Control over some data, Visualization functionality of data and documents collected for supply chain operators, Registry management and decoding, Authentication and authorization system and Relational database for storing data and documents. Upon completion of each significant micro-phase, the middleware notarizes it on the blockchain and stores it in its database accompanied by the unique code (hash) received from the blockchain itself in order to easily find the certified data when necessary.

The middleware, in addition to entering and displaying data and documents, will have to carry out:

- Generation of lot code
- Control of agricultural parameters (summation of fertilization values against threshold values) and alarm generation (or e-mail notification)
- Validation functionality of uploaded documents by sending emails to the certifiers and acquiring a response

By authenticating the operators who use the platform, access to data entry and viewing will be profiled on the basis of the authorizations granted to each type of user.

The blockchain included in the BIAS platform is a custom type Ethereum. It is a public and permissionless blockchain, with however the possibility of customizing access to data based on the type of user. In particular, through specific rules implemented within the smart-contracts, access to data will be made possible in a differentiated way for two types of users: ADMIN (with administrator privileges) and USER (with reading rights on a predefined set of data). The attribution of each individual user to the appropriate category is delegated to the middleware. The blockchain provides a smart-contract for each significant micro-phase. Furthermore, the blockchain provides some smart-contracts for access by the consumer consultation APP.

The consultation application dedicated to operators can be used to access information through QR Code or RFID using different devices. The system allows to:

- Read the packaging QRs of the product packaging using smartphones
- Read the RFID packaging with a handheld reader positioned in a fixed way.

- Read the shipment unit batch QR using a smartphone, or other mobile or fixed reader placed at gates or in desktop mode

The consumer will be able to access the information either freely, using any QR Reader, and landing on a public mini-site, or by downloading a special APP from the store, which, by reading the unique QR code present on the smart label applied to the package, they accesses the blockchain and extracts and displays a subset of the collected and certified data.

The technical improvements that can be obtained by using the proposed platform, based on the blockchain, have been significant and have made it possible to obtain many advantages for the considered Supply Chains:

- Digitization: data and information become digital (contracts, documents, etc.), as transactions entered in the chain. They can come both from data entry by human operators and from data sensory retrieved from existing management tools, sensors and/or IOT devices in the field regarding any asset.
- Security: thanks to the encryption process that characterizes the blockchain, it is not possible to change or add modifications to blocks already inserted; the data saved in it are therefore safe, certain, and not manipulable.
- Trustworthiness: being organized chronologically prevents the arising of disputes in regarding the execution, for example, of the different phases of a contract and/or of the processing algorithmic of the data provided. Smart Contracts are introduced through which it will be possible to execute the clauses of a contract between several parties through a code or set of suitably encrypted transactions which specify the contractual conditions agreed between the parties.
- Reliability: the technical characteristics of the bias platform (encryption, hashing, digital signatures, distribution, sharing, etc.) prevent any data loss or damage.
- Speed: there is no need for a central entity that verifies its adequacy and validity, this happens for consensus of the network, and being a completely digital solution, it eliminates the time of execution, controls, paper, back-office and operational risks.

The repercussions of innovation are found on all the stakeholders in the chain:

- Consumers: each customer can access the product storyboard in real time, trace its origin, view and monitor the presence of any certifications and, therefore, have guarantees on product quality and safety.
- Producers: small farmers, farms and processing companies. The characteristics of transparency, immutability, trust of the blockchain also become a powerful vehicle for demonstrate the quality and authenticity of its products and support commercial development based on a relationship of trust between the company, the consumer and the certifying body.
- Buyer: just like consumers, with BIAS they acquire the ability to access ads in real time a series of significant product data, in order to personally verify the quality, the authenticity and the presence of any product certifications.
- Certifying bodies: they acquire an additional tool to adequately control the entire supply chain.
- Technology partners: they acquire a distribution and processing infrastructure with BIAS data intelligence in the Agrifood sector that can be approached even without major computational efforts and compatible with the guidelines of transparency and accessibility of data and algorithms of the latest European regulations on the matter.