

Metrology and quality management

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Introduction: context and challenges

Demographic growth in countries south of the Mediterranean, combined with the recent migratory upheaval emanating from conflicts in the Middle East, accelerates the urban growth and the spatial concentration of populations on coastlines and estuary zones. According to consistent findings from several foresight studies conducted by the Centre International de Hautes Etudes Agronomiques Méditerranéennes (CIHEAM), the National Research Agency of France (ANR) and the Mediterranean World Economic Foresight Institute (IPEMED), these areas concentrate significant fertile agricultural land but will host 50 million more inhabitants within the coming 25 years.

Both urban demand for food and the pressure on natural resources are rising fast. Local agricultural production of cereals, meat and dairy products is increasingly inadequate to satisfy population requirements. Growing imports of

food staples are resulting in food dependency and insecurity for the majority of southern and eastern Mediterranean countries.

The political, economic and social crisis of the 2011 Arab revolutions brought significant difficulties for resource access and management to the fore, leading for example to water shortages, in spite of water availability (less than 500 m³ per inhabitant each year). In conflict situations, competition for resources involves a deregulation of the distribution systems which have long been operating and are the result of complex negotiations between actors to measure consumed quantities and delineate their usage. Under these conditions, the use of fossil vs renewable energy affects not only the quality of agricultural products but also the quality and safety of marketed and processed products.

In order to address these problems, issues which need to be taken quickly into consideration include reducing the negative impact of agriculture, livestock breeding and forestry on the environment, and enhancing positive effects such as carbon storage, soil and plant cover stabilization, or the reduction of runoff and erosion. In other words, agricultural practices which are adapted to changing climate conditions need to be initiated. This requires developing qualitative and quantitative measurement mechanisms negotiated between relevant stakeholders in order to ensure sustainability. Reliable metrics will allow for the efficient measurement of the impact of agriculture and help design agricultural policies targetting environmental protection. At the same time, better management of food waste, consumption and nutritional habits may contribute to adapting agriculture to climatic change over the medium to long term.

All these expected (or existing) disruptions involve strengthening people's capabilities to control agricultural products in order to meet present and future needs. To avoid possible failures against security as well as environmental, social and economic interests, it is necessary to enforce robust conformity assessment systems adapted to the new climate conditions and the growing demand for qualitative products.

The reliability of quality controls of agricultural products is strongly correlated to the availability of skills in the evaluation system. For instance, testing and calibration laboratories should carry out measurements according to well-proven technical prescriptions and produce results leading to the granting of conformity assessments (Lewis and Cooke, 2013).

The strengthening of capacities to control agricultural products needs to be linked to an assessment system harmonized across countries south of the Mediterranean. This system should be based on reliable, long-lasting measurements (Himbert, 2009). Quality and metrology (the science of measurements) will therefore both contribute to the assessment of climate change impact on agriculture. The European project "Quality in agricultural higher education in the Mediterranean area" (QESAMED) highlights the importance of integrating these two domains into higher education and research in order to develop the necessary skills. It is being implemented by the network of the Conservatoire national des arts et métiers (CNAM, Paris, www.cnam.fr) and the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD, Montpellier, France, www.cirad.fr).

Strengthening conformity assessment systems

There are numerous common social, economic and security interests across countries south of the Mediterranean. Quality control is a great challenge everywhere (Osseni et al. 2015). It will help minimize the risks of product characteristics failing to meet the security, standards or regulatory requirements applying to consumers' health and to the environment. Strengthening capacities for the control of agricultural products is a key component in terms of quality and measurement, which should be coordinated and agreed upon across concerned countries. Skills and means related to the process of quality control have thus to be established and harmonized in the region.

The accreditation of conformity assessment institutions (calibration and testing laboratories, inspection and certification agencies) is essential. It serves to validate practices and skills (organizational and technical) for quality checking. As illustrated in Figure 1, laboratories play a key role in the reliability of controls. They are called upon at all levels and must ensure ethical, impartial and independent outcomes. Therefore, the accreditation of these laboratories must be considered as a precondition.

Control cannot be properly implemented unless the product quality measurement system is itself controlled. Additional resources are necessary for countries to carry out regular and reliable controls.

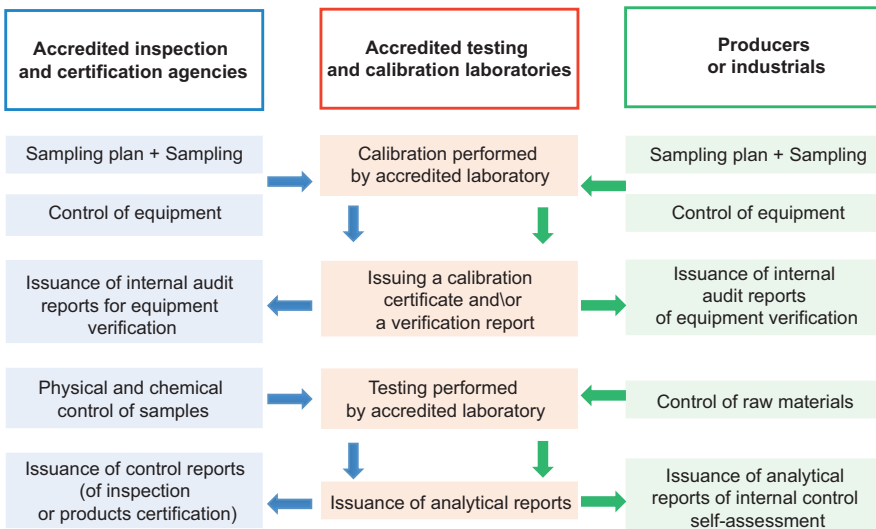


Figure 1
 Links between inspection, certification, producers/industrials and testing and calibration laboratories.

Ensuring the reliability of controls

The ISO/IEC 17025 standard clearly defines the technical requirements relative to testing, analysis and calibration laboratories. In particular, it requires the evaluation of result uncertainty (e.g. samples of an agricultural product) (Charki and Gerasimo, 2012; Charki and Louvel, 2012). To ensure reliable results, it is also important to control all the factors which may influence results (Fig. 2), i.e. equipment, method, product, environment and manpower.

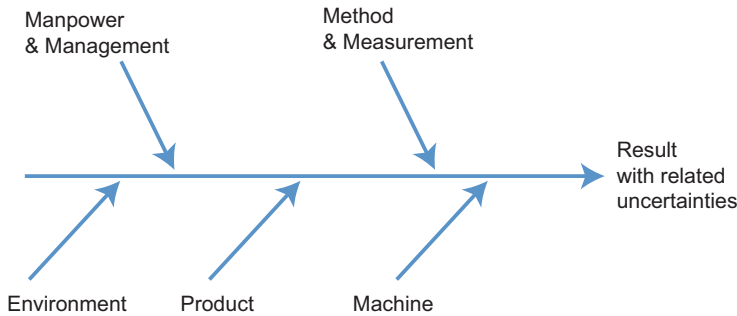


Figure 2
Detailed and up-graded diagram of Ishikawa:
5 basic tools of quality management

The following quality requirements are listed in standards ISO/IEC 17025 (2005) and ISO/IEC 17020 (2012) and need to be checked:

- Traceability requirements
- Maintenance of the equipment used for the analysis
- Control of the calibration or verification for measuring instruments
- Evaluation of uncertainty
- Assessment of the conformity of samples and equipment, etc.

Metrology and quality are thus both joint key factors for the adaptation of agriculture to climate change. They comply with customs' regulations and considerably decrease sanitary risks linked to the consumption of agricultural products.

The equipment used for result reliability (“critical” equipment) needs also to be checked through metrological control. For example, equipment used to analyze pesticide residues or organic contaminants (dioxin, polycyclic aromatic hydrocarbon, melamine, anisole, acrylamide, etc.) or for the dosage of mycotoxins and phytotoxins in foodstuffs for humans and animals (LAB GTA 21 and LAB GTA 26), such as chromatographic columns (liquid or gas, whether coupled or not with mass spectrometry), ultraviolet-visible spectrophotometer, robots of extraction and purification, volumetric instruments and climate chambers.

Integrating quality and metrology in higher education and agricultural research

Since 2005, two associations have promoted awareness-raising activities in their field of expertise in the Euro-Mediterranean region: *Quality Association in Research and Higher Education* (QUARES, www.quares.fr) and the *African Committee of Metrology* (CAFMET, www.cafmet.com). The project “Quality in Agricultural Higher Education in the Mediterranean area” (QESAMED, www.qesamed.eu), selected in the 6th call for proposals of the European Tempus IV program, was developed in conjunction with the meetings organized by these groups.

Launched in 2014, the QESAMED project has conducted quality and metrology activities in the Mediterranean area over a three-year period (2014-2016). The main objective was to develop capacities of higher and vocational education systems in French-speaking Maghreb and Middle East countries: Algeria, Lebanon, Morocco, and Tunisia. The project focuses largely on agriculture, including the food industry, and aims to professionalize quality and metrology training in higher education.

The QESAMED project relies on the skills of 23 organizations from 7 different countries, with a threefold purpose:

1. Ensure the initial training in quality and metrology for agronomy students in the Mediterranean area, including distance-learning training adapted to the context of professionals;
2. Raise awareness on quality and metrology challenges underlining competitiveness in the agricultural production sector;
3. Take into account quality and metrology requirements by institutions through research and technology transfer as well as training certification.

The project also supports research transfer initiatives for quality procedures and metrology processes. For instance, the Centre for Analysis and Characterization of Cadi Ayyad University in Marrakech is working towards accreditation and benefits from dedicated support (training courses, evaluations, etc.) by European experts.

The development of a regional network of expertise on quality and metrology in higher education and research is also necessary. It will support mainstreaming quality control in applied research and production units, and as such contribute to the economic development of Mediterranean countries.

Conclusion and perspectives

Mediterranean countries will be affected by the current ongoing climate changes, and vulnerable populations (e.g. in terms of food security, access to water and energy, etc.), especially in urban areas, will be impacted first.

The need for rapid adaptation of the agricultural sector is a vital challenge for sustainable development in the Mediterranean Basin countries. The awareness of managers and decision-makers of the importance of quality and metrology to sustain progress is essential. Skills improvement is necessary, both for strengthening the autonomous control capabilities and for enforcing the efficiency of innovation and applied research. These skills will contribute to the new paradigm of the ecological transition and ensure the development of a new, more efficient and environmentally friendly agriculture.

By coordinating the efforts of French-speaking countries of the Mediterranean Basin, the European QESAMED project contributes to the development of regional skills on quality and metrology applied to agriculture. Good research practices will enable the development of innovative solutions to best adapt agricultural practices to the challenge of climate change.

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