Consumers demand high quality fruit. But how do farmers, wholesalers and retailers assess quality non-destructively? A multi-national team of researchers believe that they can provide the answers.

Engineering research to improve fruit quality

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Participating on the European project for the past four years are six leading Agricultural Engineering organisations: Polytechnical University Madrid (UP); Katholieke Universiteit Leuven (ULEU); Scottish Centre of Agricultural Engineering (SAC); Biotechnologisk Institute Kolding (BI); Silsoe Research Institute (SRI); and Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets (CEMAGREF). The aim of the study is to improve the quality of fruit (apples, peaches, pears, and apricots) by:

- reducing losses due to damage susceptibility
- minimising damage incidence
- enhancing quality grading procedures
- monitoring surface appearance
- assessing internal quality non-destructively.

Detecting damage

Mechanical damage to fruits is mainly inflicted during field harvesting operations, but it also occurs in grading and packing lines, during transport, and in handling at the end of the supply chain during produce display and selection by retailers and consumers. A significant variation in damage is observed when comparing different procedures and different equipment. Most of the bruising damage, however, can and should be avoided by good management and attention to detail in handling processes.

Electronic fruits, already commercially available, are convenient devices for assessing potential damage in fruit handling operations. Damage is typically due to impacts, and is proportional to the applied loads and drop heights. With the appropriate testing protocols, such as those proposed in the study, the electronic fruit can pinpoint exactly where damage is occurring in a handling system. These damage points can be eliminated or reduced by better handling during the picking activity (specific recommendations are being developed), elimination of rough loading and unloading of boxes, and by padding or elimination of transfers in fruit sorting lines. In addition, a new device has been developed to measure the static compressive forces on fruit in containers, as well as new models of electronic fruits.

Fruit-by-fruit assessment is essential in an effort to maintain uniformity of appearance and consistency of internal quality. This is very labour intensive and a high level of operator efficiency on a grading line is difficult to sustain over the normal working period. There is real scope for the introduction of objective measurement techniques and equipment on grading lines. Such monitoring devices are being developed for firmness, appearance and internal quality (sugar content).

Monitoring firmness

Firmness can be measured by contact (impact and compression) and by resonant frequency techniques. Both manual and automatic laboratory devices

Contractors of the CAMAR project participating in a collaborative testing campaign in Madrid. Left to right: Andrew Muir [UK], Quingseng Yang [UK], Calum Dewar [UK], Vincent Steinmetz [F], Josse De Baeremaeker [B], Pilar Barreiro [ES], Liesbet Verstreken [B], Jose Briz [ES], Jose Luis Garcia [ES], Margarita Ruiz-Altisent [ES], Jesper Kamp [DK], Robin Tillet [UK].
are now in use to measure impact and
compression firmness of apples, pears and
peaches, and the prototypes under evaluation
have potential as on-line equipment. Within
the project, the development of firmness
measurement by resonant frequency offers
the important advantage of a softer and simpler
way of "touching" the fruit. The outcome of
the three measurement procedures for firmness
have been compared with the destructive
Magness-Taylor penetration test for firmness
and with the degree of ripening in peaches,
apples and pears. Firmness is related to colour
in fruit development during post-harvest
ripening, data on colour and on colour
uniformity having been analysed in
combination with firmness. These two factors
and other quality attributes, such as external
appearance and sugar content, can be
integrated by sensor combination procedures
into a unique fruit classification system.

Imaging blemishes and sugar

The external appearance is evaluated by means
of a defect recognition technique which can
discriminate between the common external
blemishes in fruit. Images of each fruit are
captured sequentially and analysed
immediately using image analysis techniques
similar to those already applied to size and
partially to colour measurement. Insect holes,
diseases and wounds are the easiest ones to
detect, whilst bruises are more difficult.
In order to achieve a feasible procedure, complex
algorithms have been developed to interpret
the data collated from the optical scanning
equipment. Further, a portable detector for
recognising diseases and defects in fruit and
in other agricultural produce has been
demonstrated as a first prototype.

Light reflectance in the near infra-red range is used for the measurement of sugar
content. A camera image is also captured for
this purpose and specific data analyses can predict the sugar content of apples with a
precision of 1.4° Brix. On the basis of these
results, a device for on-line mounting is well
advanced.

General Information

The sector consists of some 300 companies of which 140
have over 10 employees. There are
three bigger companies of which
two belong to the same concern.
In all, about 5000 employees work
in the industry. The great majority
of these companies are members
of NATI. The Dutch manufacturers
specialise in light machinery,
installations and equipment. The
products vary from simple
implementations to manure processing
systems, harvesting machines,
complete barn installations and
computer-controlled systems.

In their specialist fields the
companies are among the international
leaders, a position which has been
achieved by continuously improving
equipment and techniques. Machines
are being developed to operate both more
efficiently and at a higher quality
standard. The strict specifications in
the Netherlands make agrarian Holland an
ideal testing ground. In addition, there
is a very close co-operation between the
manufacturers, the users, and the
agricultural institutes and universities.
These links enable the manufacturers of
agricultural machinery and equipment
to react quickly and effectively to new
trends in this sector. Currently, more
than 65% of the total production of the
sector is being exported.

Activities

• Protecting the techno-economic
  interests of the Dutch agricultural
  industry.
• Conducting research and market
  investigations.
• Influencing international
  standardisation.
• Providing information about guidelines,
  standards, regulations and legislation.

Ing R Westerbeek is Secretary of the
Nederlandse Agrotechnische Industrie
(NATI), a joint branch group of the
Metaalunie and the FME for
manufacturers of agricultural
machinery and equipment.

• Undertaking joint projects regarding
  quality assurance, etc.
• Introducing micro-electronic to the
  sector.
• Promoting exports through joint
  presentations at foreign exhibitions
  and by trade initiatives.
• Discussing price structures.
• Regulating exhibitions both at home
  and abroad.
• Informing users and dealers and
  responding to their queries.
• Functioning as an intermediary for
  international supply and demand.

Participation

NATI is among others represented in:
CEMA (Comité Européen des
Groupements de Constructeurs du
Machinisme Agricole), an European
association of manufacturers’
organisations, which protects the
international interests of the
manufacturers.

Federatie Agrotechniek, a federation
involved in the exhibition policy in the
Netherlands and in taking care of the
common interests (for example,
legislation) of all parties in the
manufacturing and trading of equipment.

SAP (Stichting Agrotechnisch Platform),
a foundation promoting efficient
mechanisation in Dutch agriculture;

NNI (Nederlands Normalisatie
Instituut), the committee Agricultural
Implements of this National
Standardisation Institute judging, among
others, ISO and European standards for
agricultural implements.

The Future

Characterised by a high degree of
flexibility, the progressive agricultural
machinery industry has good prospects,
Despite the worsening position of the
agricultural sector. Signals from the
market in the field of mechanisation,
ammoniation and new crops are promptly
converted into a product modifications or
new machinery. The same response is
applied to public perceptions regarding
environmental care. As a result of this
approach, rapid developments are visible
concerning:

- slurry storage, handling and injection
  systems
- crop protection techniques
- automation of milk and feeding systems
- automation of registration and
  identification systems
- quality improvement of harvesting
equipment
- mechanical weed control equipment
- business management systems

Changing mechanisation trends
and the open European market, together
with the high quality standard and the
flexibility of the Dutch agricultural
machinery industry, offer positive
opportunities for the inventive
entrepreneur.