

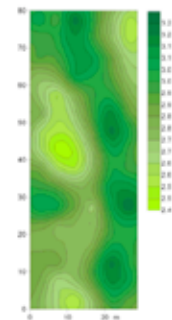
Principles and applications of Multiplex and Dualex: innovative tools in the service of viticulture and oenology



Zoran G. Cerovic

CNRS, Univ. Paris-Sud, Orsay, France

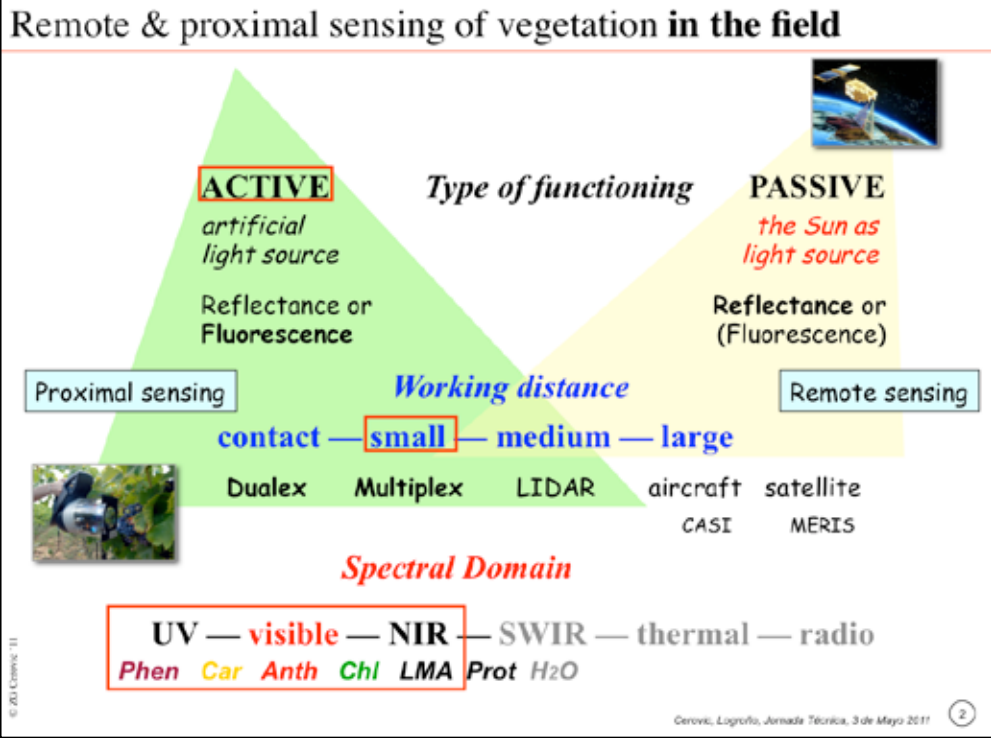
zoran.cerovic@u-psud.fr



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DON'T WORRY IF YOU MISS SOMETHING:
I WILL REPEAT 3 OR 4 TIMES THE SAME THING AND WILL GIVE
YOU A SUMMARY AT THE END.



I HAVE BEEN ASKED TO PRESENT HERE TWO SENSORS:
 THE DUALEX AND THE MULTIPLEX PRODUCED BY FORCE-A THAT BELONG TO THE CATEGORY OF ACTIVE PROXIMAL (SMALL DISTANCE) OPTICAL SENSORS WORKING IN THE UV-VIS REGION OF THE SPECTRUM THAT CAN BE USED IN THE FIELD IN FULL SUNLIGHT.
 I WILL NOT ADDRESS THE QUESTION OF REMOTE SENSING, NOR IMAGING OR NIRS.

Layout of the presentation

Acquiring information on the status of the vines

- with WHAT • Dualex & Multiplex
- HOW • Hand-held vs. vehicle mounted
- WHAT • Pigments in leaves and fruits
- WHY • Vigour & quality
- what ELSE • Diseases & research



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HOW CAN OPTICAL OTICAL SENSORS HELP VITICULTURISTS PRODUCE HEALTHY GRAPES OPTIMISED FOR THE WINE THEY WANT TO MAKE.

IT IS WELL KNOWN THAT HEALTHY WELL BALANCED VINES YIELD HEALTHY GOOD QUALITY GRAPES FOR PREMIUM WINES. THE VEGETATIVE PHASE (LEAVES-CANOPY) INFLUENCES THE REPRODUCTIVE PHASE (GRAPES), THEREFORE WE NEED **INFORMATION** ON BOTH.

HOW CAN WE OBTAIN THIS INFORMATION? BY USING DUALEX & MULTIPLEX, EITHER HAND-HELD OR VEHICLE MOUNTED, IN ORDER TO MEASURE PIGMENTS IN LEAVES OR FRUITS, TO ASSESS VINE VIGOUR OR GRAPE QUALITY.

IN ADDITION I WILL MENTION AT THE END FUTURE USES.

Optical decision support tools

leaf-clip



Dualex:

Chlorophylls
Flavonols



proximal sensor : leaves and grapes



Multiplex:

Chlorophylls
Flavonols
Anthocyanins
(Stilbenes)



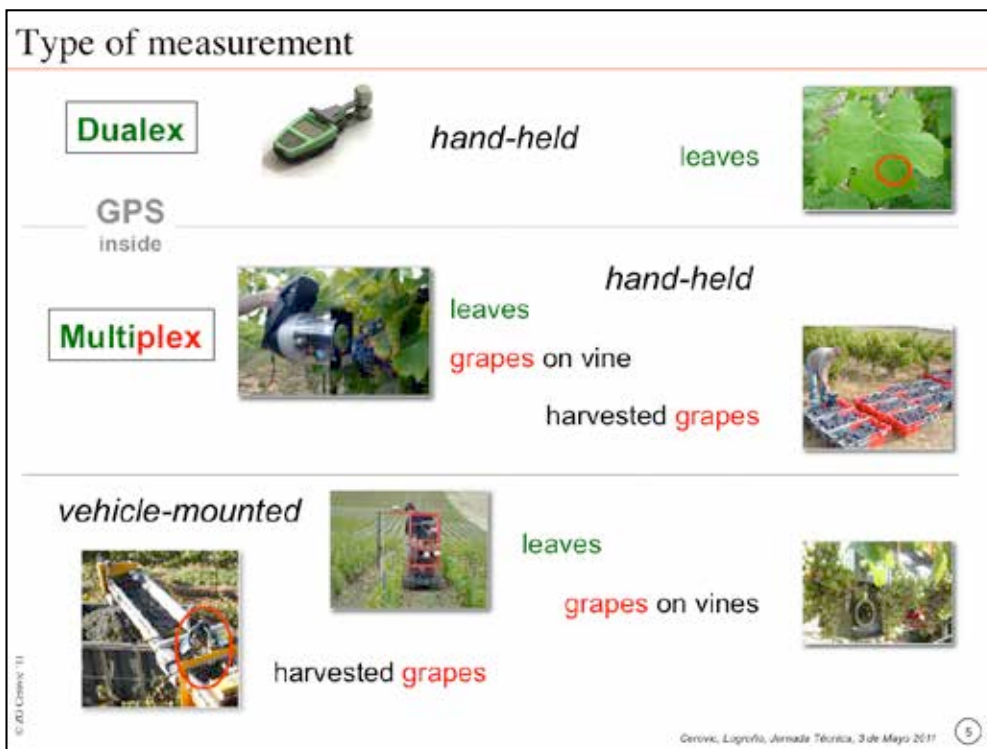
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DUALEX IS A SMALL LEAF-CLIP (200 G) THAT MEASURES LEAF CHLOROPHYLL & FLAVONOLS.

MULTIPLYX IS A HAND-HELD NON-CONTACT SENSOR (2 KG) THAT MEASURES CHLOROPHYLL, FLAVONOLS, ANTHOCYANINS (AND STILBENES, BUT THE LATTER STILL NOT COMMERCIALY AVAILABLE).

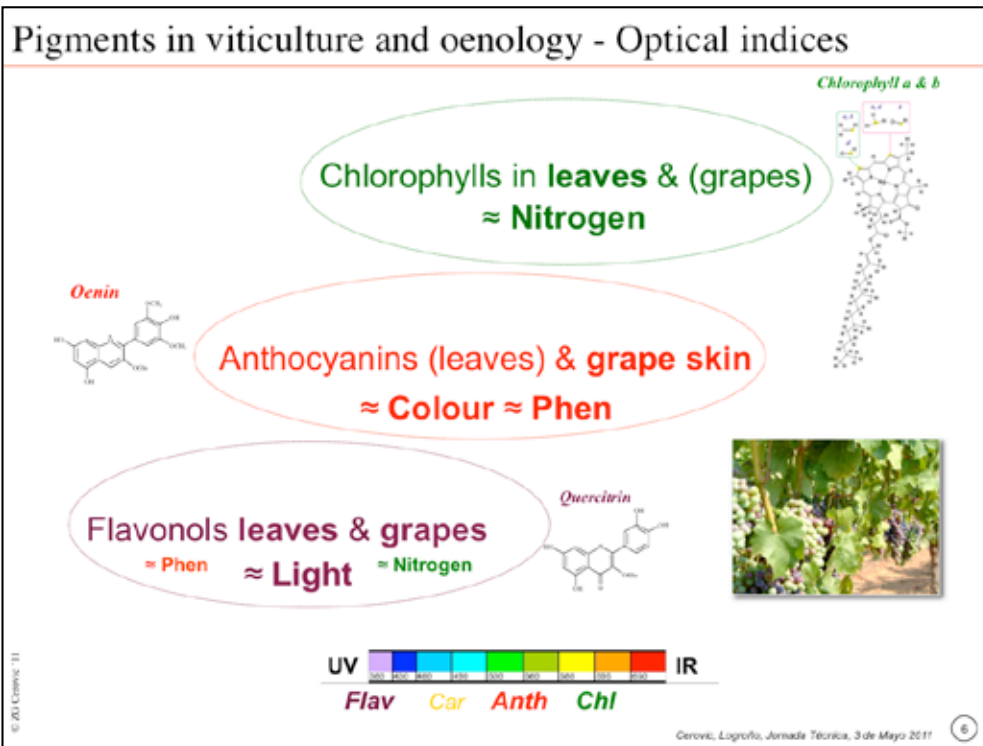


MEASUREMENTS ARE VERY RAPID (LESS THAN A SECOND).

MEASUREMENTS CAN BE ALL GEO-LOCALISED (TO MAKE MAPS) BECAUSE THEY ALL HAVE AN INTERNAL GPS.

DUALEX IS USED HAND-HELD ON LEAVES. MULTIPLEX IS USED HAND-HELD ON LEAVES OR GRAPES, THE LATTER STILL ON VINES OR HARVESTED.

MULTIPLEX CAN BE VEHICLE-MOUNTED FOR LEAVES (CANOPY) OR GRAPES MEASUREMENT, THE LATTER AGAIN STILL ON VINES OR HARVESTED.



THESE SENSORS MEASURE PIGMENTS ABSORBING UV OR VIS LIGHT.

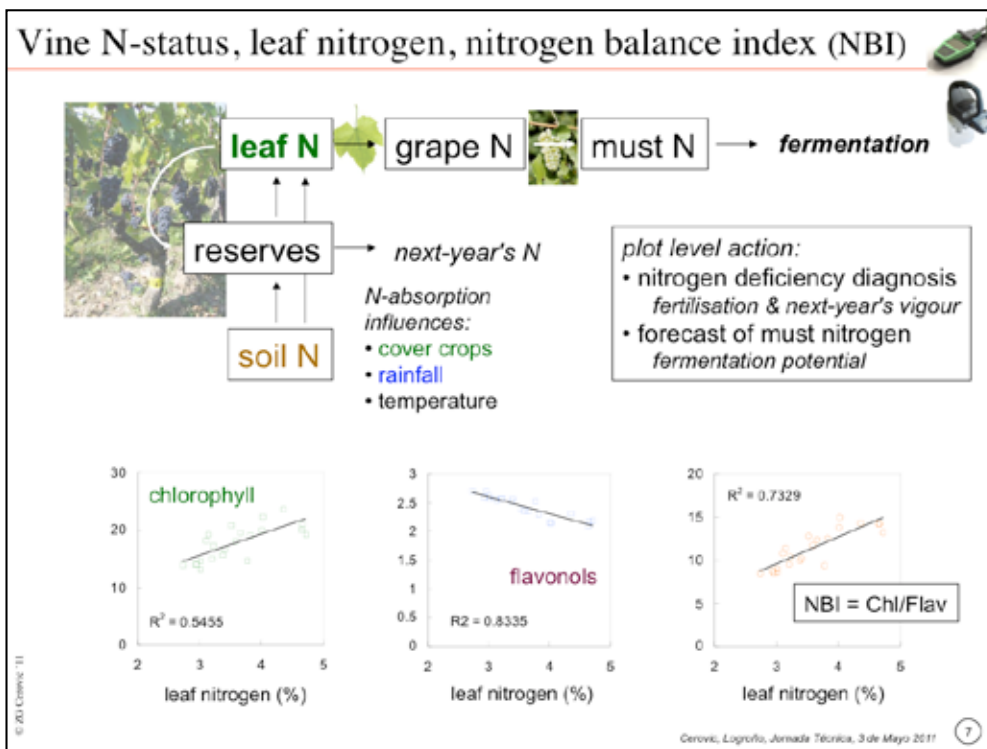
CHLOROPHYLL PRESENT IN LEAVES & GRAPES IS AN INDICATOR OF NITROGEN NUTRITION AND MATURITY, RESPECTIVELY.

ANTHOCYANINS CONFER THE RED OR BLUE COLOUR TO GRAPES (AND SOMETIMES ARE PRESENT EVEN IN LEAVES).

THEY ARE A GOOD INDICATOR OF POTENTIAL WINE COLOUR OF TOTAL PHENOLICS (TANNINS), AND WINE FLAVOUR.

FLAVONOLS ABSORBING UV LIGHT ARE GOOD INDICATORS OF RECEIVED (INTERCEPTED) ILLUMINATION BY THE VINE BUT THEY ARE ALSO INDICATORS OF NITROGEN IN THE LEAF (THIS IS LESS WELL KNOWN).

(CF. NEXT SLIDE).



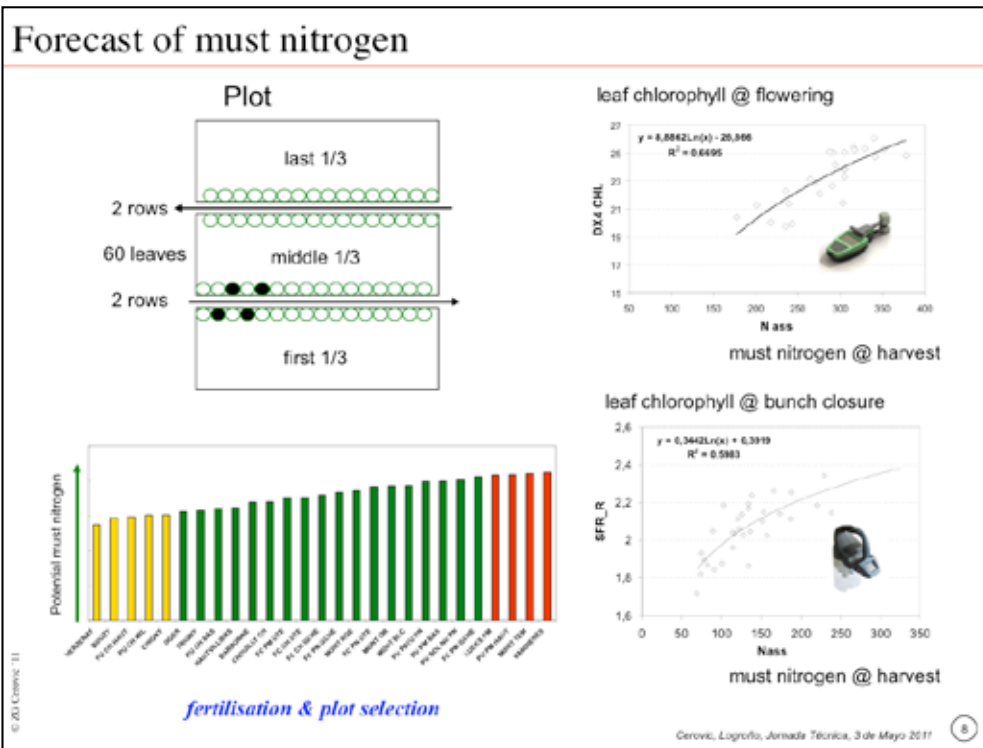
THIS IS THE FIRST OF 3 SLIDES TO ILLUSTRATE THE USE OF SENSORS ON LEAVES (DURING THE **VEGETATIVE PHASE**)

LEAVES OBTAIN THE NITROGEN FOR GROWTH AND DEVELOPMENT FROM RESERVES (WOODY STEMS AND ROOTS) AND FROM SOIL. NITROGEN WILL BE TRANSFERRED TO GRAPES AND THEREFORE TO MUST, WHERE IT DEFINES THE POTENTIAL FOR YEAST FERMENTATION (FERMENTABLE N) (YEAST ASSIMILABLE N).

N-DEFICIENCY IN LEAVES CAN BE AN INDICATOR OF PROBLEM IN MUST, BUT THE VARIATIONS OF N IN A LIGNEOUS SPECIES LIKE GRAPEVINE ARE VERY SMALL, DIFFICULT TO ASSESS.

CHLOROPHYLL REFLECTS LEAF N, MORE N > MORE CHL, BUT FLAV REFLECTS ALSO LEAF N, MORE N > LESS N (OPPOSITE EFFECT). THE RATIO OF THE TWO CALLED NITROGEN BALANCE INDEX (NBI) CAN BE MEASURED BY BOTH DUALEX AND MULTIPLEX (PATENTED).

IT IS VERY SENSITIVE TO N-DEFICIENCY, AND, REACTS EARLY IN THE SEASON.



HOW IS IT DONE PRACTICALLY?

60 LEAVES MEASURES IN TWO REPRESENTATIVE ROWS.

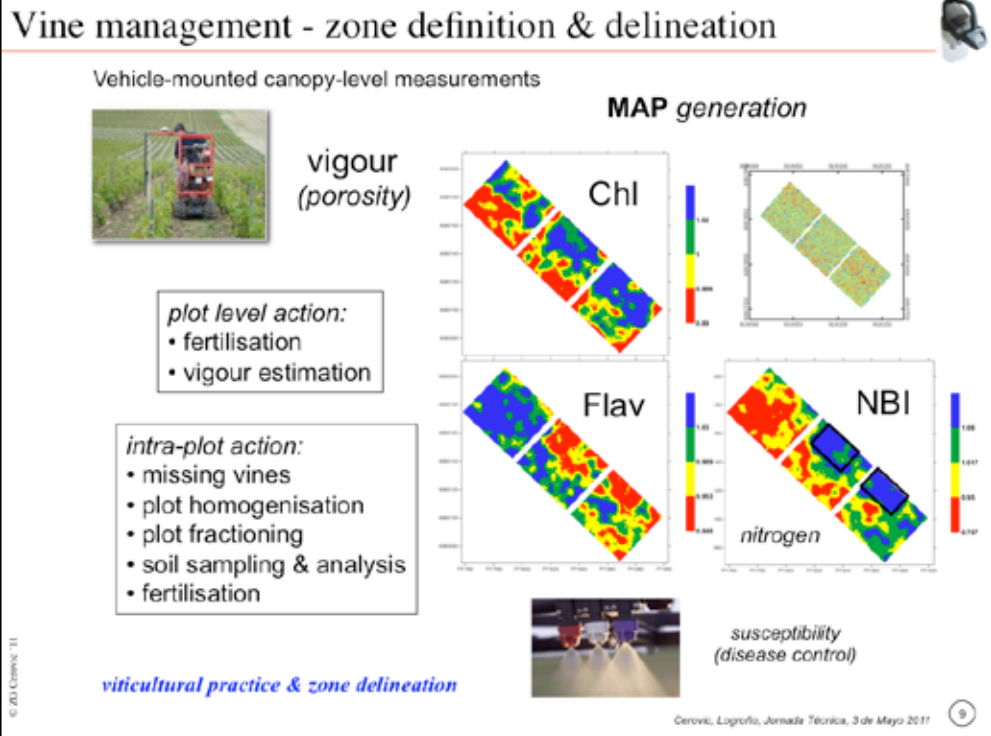
ASSESSMENT CAN BE DONE BY DUALEX OR MULTIPLEX AT EARLY STAGES, FLOWERING OR BUNCH CLOSURE, PRESENTED HERE AGAINST MUST NITROGEN (AT HARVEST).

SO, MUST NITROGEN CAN BE FORECASTED AND FERTILISATION CAN STILL BE ENVISAGED.

EXAMPLE OF 27 PLOTS CLASSED THIS WAY IN CHAMPAGNE: 5 PLOTS WERE AT THE LIMIT OF DEFICIENCY AND

EITHER ADDITIONAL LEAF FERTILISATION OR ADDITION OF DIAMMONIUM PHOSPHATE IN THE MUST CAN BE ENVISAGED. 4 PLOTS HAD RATHER HIGH N, SO POSSIBLE FERMENTATION HAZE HAS TO BE CONTROLLED

AND COVER CROP ADDITION CAN BE ENVISAGED FOR NEXT SEASON.

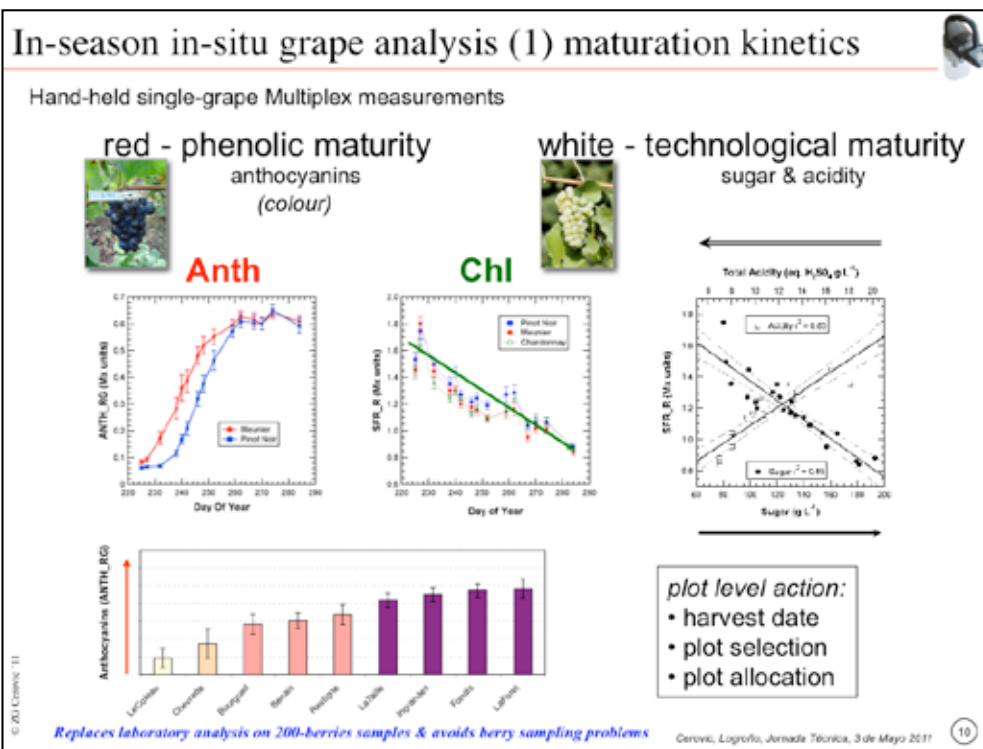


IN ADDITION, MULTIPLEX CAN BE MOUNTED ON VEHICLES (TRACTORS) AND MILLIONS OF MEASUREMENTS MADE ON-THE-GO (IN MILLISECONDS) PRODUCING MAPS OF VIGOUR (CANOPY POROSITY) AND NBI OF THE WHOLE PLOT.

THIS ALLOWS PLOT LEVEL AND INTRA-PLOT LEVEL ACTIONS THANKS TO PRECISE ZONE DELINEATION.

EXAMPLE OF TWO ZONES OF HIGH NBI WITH INCREASED SUSCEPTIBILITY TO BOTRYTIS (OR OTHER DISEASES).

ONE CAN ADAPT (THE FUNGICIDE) TREATMENT ACCORDINGLY. WE HAVE A REAL TOOL FOR PRECISION VITICULTURE HERE.

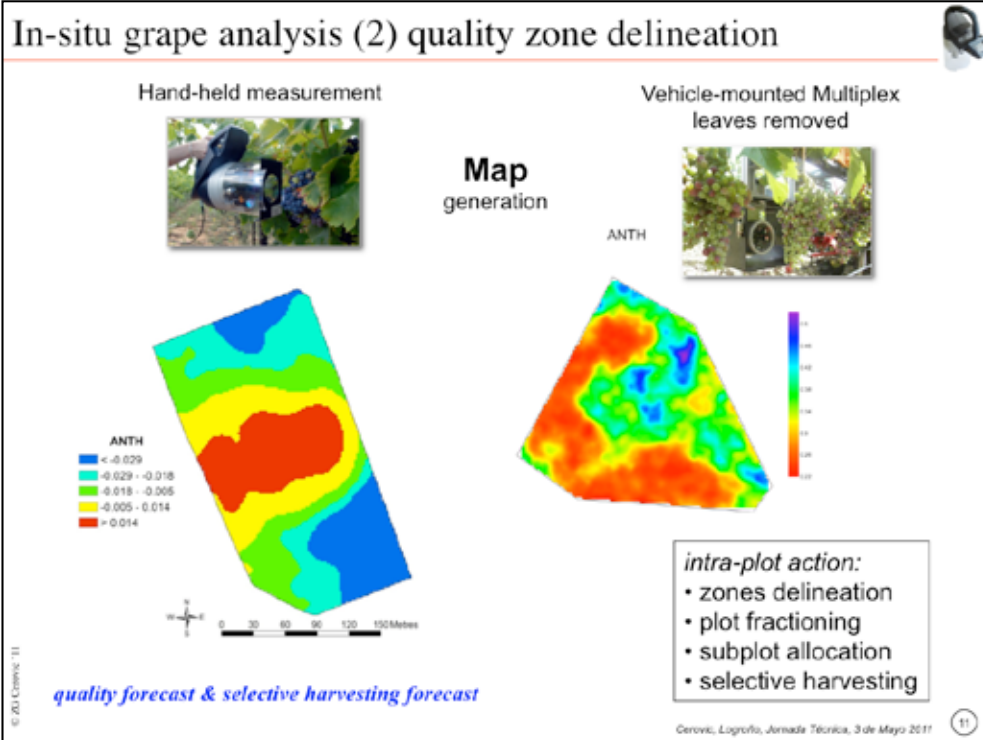


THIS IS THE FIRST OF 5 SLIDES TO ILLUSTRATE THE USE OF SENSORS ON GRAPES (DURING THE **REPRODUCTIVE PHASE**). HAND-HELD MEASUREMENTS ARE MADE ON INDIVIDUAL BUNCHES BY THE MULTIPLEX, USUALLY ON 40 TO 60 BUNCHES PER PLOT. KINETICS OF GRAPE PHENOLIC MATURATION CAN BE ASSESSED RAPIDLY IN REAL-TIME AND NON DESTRUCTIVELY (IF WANTED EVEN ON THE SAME BUNCHES).

MEUNIER MATURES EARLIER THAN PINOT NOIR (FOR EXAMPLE). THE OPTIMAL HARVEST DATE CAN BE DEFINED DEPENDING ON WANTED TYPE OF WINE. AGAIN, PLOTS CAN BE CLASSIFIED. HERE THE EXAMPLE IN THE LOIRE VALLEY:

2 PLOTS SHOULD BE DEDICATED TO ROSE WINE, 3 PLOTS FOR STANDARD WINE, 4 PLOTS CAN MAKE SUPERIOR (PREMIUM WINE).

MULTIPLEX CAN ALSO BE USED FOR WHITE CULTIVARS. CHLOROPHYLL DECREASE IS MONITORED. CHL INDEX IS DECREASING WITH MATURATION (IN ALL CULTIVARS RED & WHITE). IT CORRELATED WELL WITH THE INCREASE IN SUGAR AND DECREASE IN ACIDITY.



THANKS TO THE PRESENCE OF THE INTERNAL GPS, EVEN HAND-HELD MX MEASUREMENTS CAN YIELD

MAPS OF GRAPE ANTHOCYANINS – GRAPE QUALITY (HUNDREDS OR THOUSANDS 1-S MEASUREMENTS).

EVEN FASTER MAPS ARE GENERATED BY VEHICLE-MOUNTED MULTIPLEX, BUT **LEAVES HAVE TO BE REMOVED** (OFTEN CLOSE TO HARVEST).

HARVEST ZONES CAN BE DELINEATED FOR SELECTIVE HARVESTING (OR EVEN FUTURE PLOT FRACTIONING IF REPEATEDLY FOUND).

Seeing is believing



Genovik, Logroño, Jornada Técnica, 3 de Mayo 2017

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THIS SLIDE CONFIRMS THAT GRAPES WITH HIGHER ANTHOCYANIN CONTENT ARE OFTEN PRESENT ON LESS VIGOROUS VINES (cf. GOOGLE), BUT VIGOUR ESTIMATION IS NOT SUFFICIENT


BEST GRAPES (AND BEST QUALITY/YIELD RATIO) IS GIVEN BY WELL BALANCED VINES.

GRAPES ANTHOCYANIN CONTENT IS THE ONLY OBJECTIVE CRITERION FOR A GIVEN YEAR (DRY OR WET).

Harvested grape analysis - diagnosis & control

Hand-held at reception

single-grape measurement




plot level action:

- differential payment
- practice verification
- forecast verification
- selection & allocation

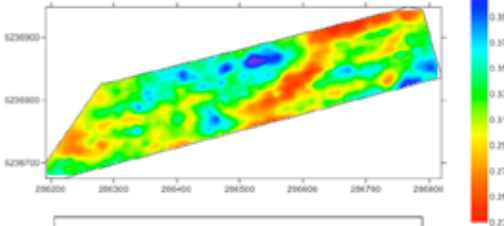
quality diagnosis & selective harvesting

Mounted on harvester

continuous measurement



harvest map generation



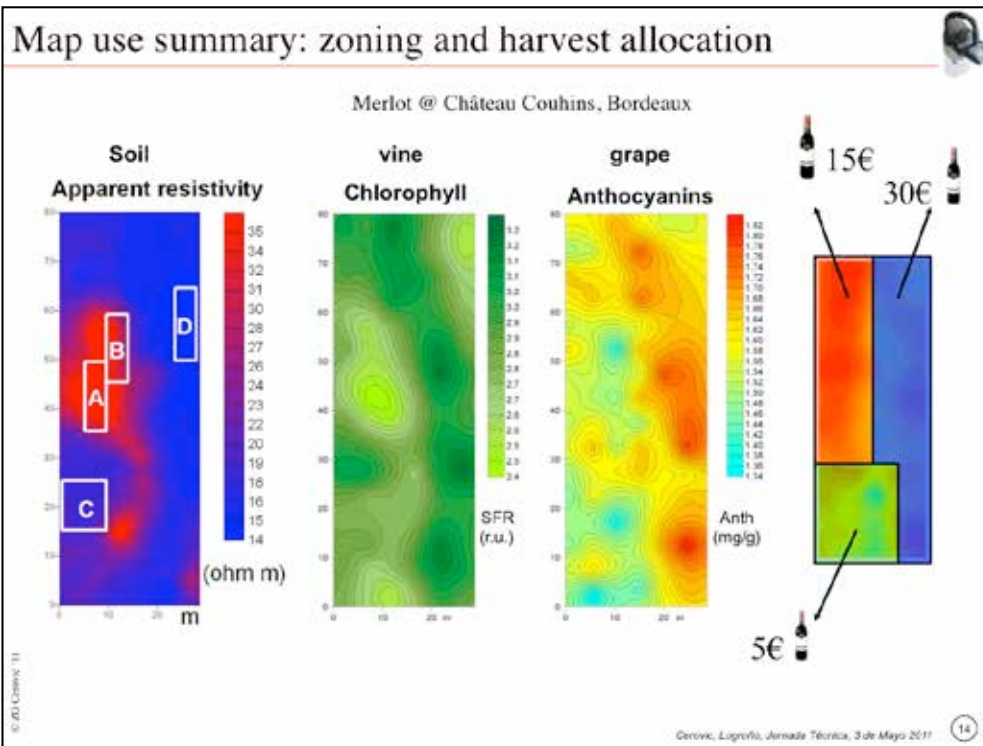
intra-plot action:

- non-grape matter estimation
- on-the-go selective harvesting

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AS I JUST SAID, MULTIPLEX CAN BE USED TO VERIFY THE QUALITY OF **HARVESTED** GRAPES AT THE RECEPTION DOCK IN THE HAND-HELD MODE OR MOUNTED ON MECHANICAL HARVESTERS: THE WHOLE CROP IS MEASURED AND MAPS GENERATED.

MULTIPLEX IS THE FIRST DEVICE ALLOWING SELECTIVE HARVESTING BASED ON PHENOLIC MATURITY (EVEN ON-THE-GO) (NEW TWO-BIN MECHANICAL HARVESTERS ARE IN DEVELOPMENT).



HERE IS FIRST A SMALL SUMMARY EXAMPLE (OF ALL THAT HAS BEEN SAID).

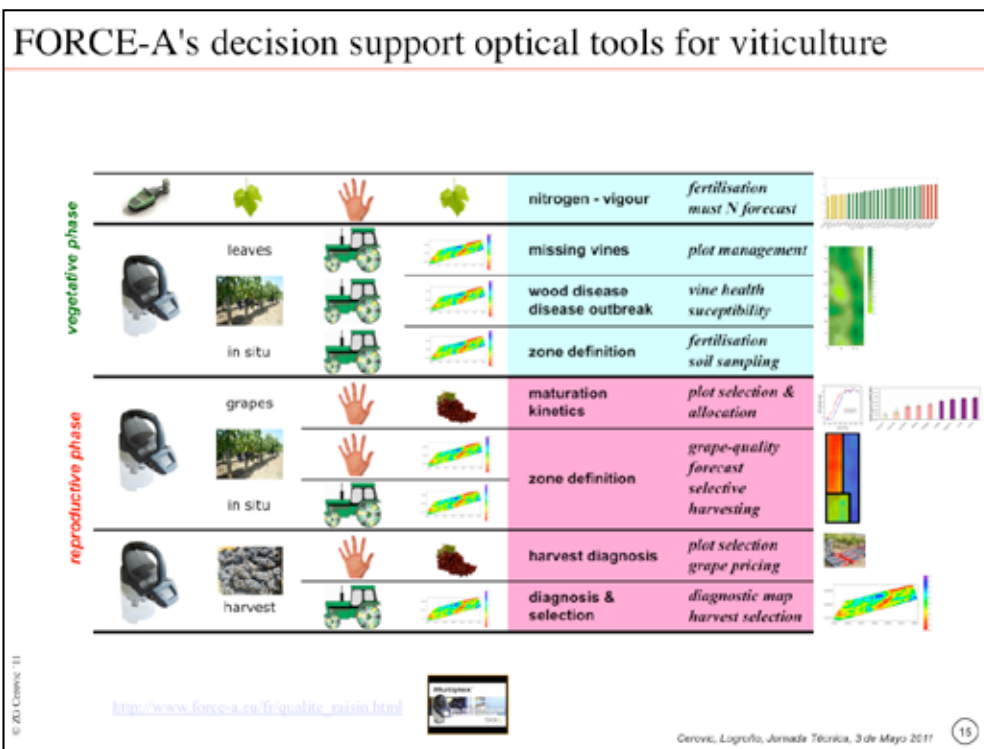
IT IS A SANDY EXPERIMENTAL PLOT IN BORDEAUX OF KNOWN SOIL DISTRIBUTION: A&B +GRAVEL, D +CLAY, C +ORGANIC MATTER.

THE VEGETATIVE PHASE REFLECTS THE SOIL TYPE.

THE REPRODUCTIVE PHASE FOLLOWS A PATTERN SPECIFIC TO THAT YEAR.

PLOT CAN BE SEGMENTED IN 3 PARTS FOR OPTIMUM PROFIT BASED ON 3 ZONES FOR 3 WINES.

THIS CAN BE EXTENDED TO LARGE SCALE.



HERE IS A GENERAL SUMMARY AS A TAKE-HOME MESSAGE.

MANY COMBINATIONS OF:

2 SENSORS (DUALEX OR MULTIPLEX)

2 TYPES OF SAMPLES (LEAF OR GRAPE), IN SITU OR HARVESTED (2)

2 TYPES OF MEASUREMENTS (HAND-HELD OR VEHICLE-MOUNTED)

2 TYPES OF INFORMATION, PLOT AVERAGE OR MAP

CAN BE USED TO YIELD USEFUL INFORMATION FOR BEST VITICULTURAL PRACTICE IN VEGETATIVE AND REPRODUCTIVE PHASE:

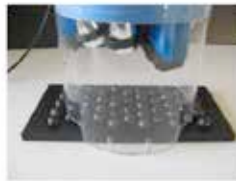
Reed the figure: nitrogen > fertilisation...

//THERE IS A VIDEO ON SAMPLING ON THE WEB SITE OF FORCE-A//

Multiplex measurements on berries in the laboratory



NO
extraction
needed



30 or
100 or
200-berries
samples



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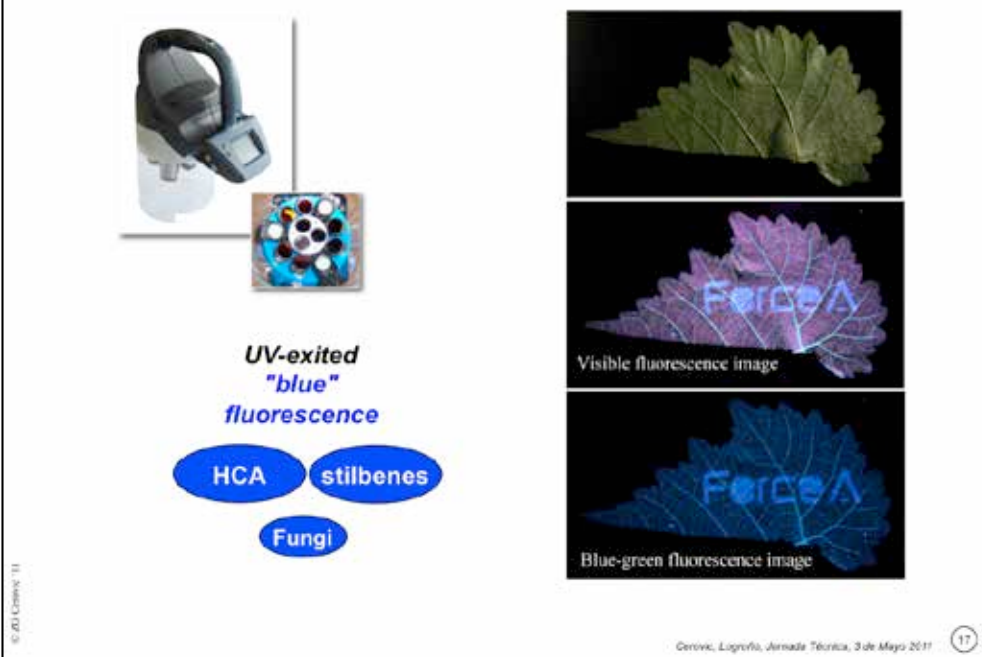
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BEFORE LEAVING THE STAGE I WOULD LIKE TO MENTION TWO MORE THINGS.

MULTIPLEX CAN OF COURSE BE USED ALSO IN THE LABORATORY TO ANALYSE BERRIES WITHOUT EXTRACTION.

Tools for research and new developments



MULTIPLEX HAS 4 SOURCES AND 3 DETECTORS THEREFORE 12 SIGNALS ARE PRODUCED THAT ARE USED FOR **RESEARCH** IN VITICULTURE BUT ALSO OTHER CROPS.

MORE IMPORTANTLY, IT IS CONSTANTLY IMPROVED.

SO, A NON-COMMERCIAL VERSION EXISTS THAT CAN DETECT THE PRESENCE OF DOWNY MILDEW

FROM BLUE FLUORESCENCE OF STILBENES.

HERE IS AN ILLUSTRATION:

A LEAF WAS IRRADIATED THROUGH THE LOGO OF FORCE BY UV-C KNOWN TO INDUCE STILBENES, SYNTHESISED BY GRAPEVINE TO PROTECT IT SELF.

THE EXACT SAME LEAF SEEN UNDER VISIBLE LIGHT (PHOTOGRAPH) AND UNDER UV LIGHT IS COMPARED:

CHLOROPHYLL FLUORESCENCE IS RED AND STILBENES FLUORESCENCE IS BLUE.

YOU SEE THE INVISIBLE TO THE EYE.

Dr. Zoran G. Cerovic,
CNRS, Univ. Paris-Sud, Orsay, France
zoran.cerovic@u-psud.fr



FORCE-A
Centre Universitaire Paris Sud,
Bât. 503
91893 ORSAY Cedex
France
Tel : +33 (0)1 69 35 88 62
Fax : +33 (0)1 69 35 88 97
www.force-a.com
info@force-a.fr



http://www.force-a.eu/fr/qualite_raisin.html

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THIS IS ACTUALLY ONE OF THE MOTTOS (SLOGAN) OF FORCE-A THE COMPANY PRODUCING DUALEXX AND MULTIPLEX FROM WHICH YOU CAN OBTAIN ALL FURTHER INFORMATION AND BROCHURES.