Drivers and Barriers For the Adoption of Precision Irrigation in Europe

Francesco Galioto, David Cuming, Meri Raggi, Davide Viaggi
University of Bologna
francesco.galioto@unibo.it

Motivations and key concepts

The European Union recently funded the FIGARO project under the FP7 program the objective of which is to create an innovative virtual platform able to combine and manage information from sensors, meteorological stations, and crop growth models to advise farmers when, and how much, to irrigate.

PRECISION IRRIGATION (PI)

PI is a system that supports end users' decisions providing quality, up to date information, lowering the risk of experiencing adverse impacts on farm income and on the environment (water and energy saving)

Objectives

QUESTIONS

1. *Under which circumstances does PI affect input uses?*
2. *How it is possible to assess the additional information introduced by PI?*

PURPOSES

1. *Obtain the relevant intuitive insight of experts and their informed judgement about those factors considered relevant in conditioning the adoption of PI*
2. *Development of an assessment methodology which include the main issues addressed in the previous task*

Framework of investigation

Factors conditioning the transition from 'traditional' to 'modern' irrigation technologies (solid empirical evidences):

Environmental Sphere
Climate conditions, Sources of water, Land quality

Regulatory Sphere
Subsidies, Water pricing policies, Regulatory clearing, Monitoring capacity

Farm Sphere
Land ownership, Type of crops, Farmer networks, Farmer skills, Monitoring capacity, Costs of subs. inputs, Output price

Framework of investigation

Factors conditioning the transition from 'conventional' to 'new' irrigation technologies (case study findings):

Environmental Sphere
Climate conditions, Sources of water, Land quality

Regulatory Sphere
Subsidies, Water pricing policies, Regulatory clearing, Monitoring capacity

Farm Sphere
Land ownership, Type of crops, Farmer networks, Farmer skills, Monitoring capacity, Costs of subs. inputs, Output price

Methodology

The identification of a methodology for assessing the adoption of PI is an hard issues due to the uncertainty caused by:

- *insufficient data on the problem under investigation*
- *incomplete theory on both its cause and effects*

1st step: provision of an heuristic approach to detect which factors are more likely to condition the adoption of PI and which could be the relevant impacts – **Delphi method**

2nd step: development of an assessment criterion which is coherent with previous findings and with the type of innovation at stake – **Value of Information (VOI)**

Methodology

Delphi Method

Is a structured process for collecting and distilling knowledge from a group of experts by means of a series of questionnaires interspersed with controlled opinion feedback

Process adopted for the present study:

***Invitation letter** – introduction of the relevant key concepts for PI*

***1st round** – classification of a list of factors which may condition (limit/foster) the ad. of PI in the region where resp. operates*

***Processing** – rearrangement of the information collected during the previous round addressing the main divergences on responses and the relevant motivation.*

***2nd round** – presenting back results from the first round asking for confirmation about first judjment and for suggesting some policy initiative to overcome any limitation addressed by resp.*

Methodology

Value of Information (VOI)

Is the difference between expected utility with and without PI, where PI is considered a technology which improve the quality of available information and raises the capabilities to manage such additional information

$\Omega(\mu) = E[\pi\ (a_{s.\mu^i}(x)) - \pi\ (a_{s.\mu^j}(x))]$

where,

$E_i[\pi\ (a_{s.\mu^i}(x))] = \sum_{\mu^i,s} P_{s.\mu^i} Q_{\mu^i} \pi\ (a_{s.\mu^i}(x)),$

$P_{s.\mu^i} = P_{s.0} Q_{\mu^i.s} / Q_{\mu^i}$ *Bayes Theorem*

farmer willingness to adopt PI is conditioned by:

1) his/her prior probabilities
2) the predictability of comparing sources of inf.
3) the consequences ass. with a farm's actions

i = adoption of PI, j = non adoption of PI

x = factors conditioning the use of resources a

s = state of the world (rain, no rain)

μ_i, μ_j = message offered with the conventional, j, and with the new message service, i

$E_i[\pi\ (a_{s.\mu^i}(x))$ = expect. profits given message service i

Q_{μ^i} = uncond. probability of receiving message μ;

$P_{s.\mu^i}$ = cond. probability of state s given message μ;

$P_{s.0}$ = uncond. probability of state s;

$Q_{\mu^i.s}$ = cond. probability of message μ given state s;

1° step – Delphi study Results

General information about the survey

COUNTRY	PROVINCE	TYPE OF RESPONDENTS	NUMBER OF RESPONDENTS IN THE FIRST ROUND	NUMBER OF RESPONDENTS IN THE SECOND ROUND
DENMARK	SOUTH JUTLAND	Researchers	4	2
GREECE	REGION OF EASTERN MACEDONIA-THRACE	Advisors and Researchers	5	5
ITALY	EMILIA ROMAGNA	Advisors	4	3
PORTUGAL	PROVINCES OF SANTAREM, SETUBAL AND ALENTEJO	Advisors	6	4

1° step – Delphi study Results

SWOT analysis of the uptake of PI

STRENGTHS	WEAKNESSES
Energy saving: the use of energy to irrigate is a key component for all types of irrigated crops, with particular reference to maize and potatoes. **Water saving**: the possibility of increasing water productivity with PI is particularly evident for SR as it limits the risk of water shortages and increases irrigation capacity. **Optimizing fertigation**: increasing water productivity as an impact also in reducing nutrient leaching (addressed by NR).	**Investment costs**: these costs limit the adoption of PI mainly for farmers with low financial capacity (addressed by most of the respondents from SR). **Labour efforts**: this issue was addressed by DR for big farms that are reluctant to the adopt PI due to managerial constraints. **Requirement of highly-skilled labour**: in Southern Europe aging and low educational levels inhibit farmers' attitude to innovation (addressed by most of the respondents from SR).

1° step – Delphi study Results

SWOT analysis of the uptake of PI

OPPORTUNITIES	THREATS
Low water availability: where water resources are limited, water productivity is important (addressed by SR). **Low levels of Field Capacity**: increasing coarse soil texture increases the frequency of irrigation interventions and the opportunity to save water and energy using PI. **High irregularity in the orography**: irregular orography seems to foster the adoption of PI, as this technology should guarantees a more homogeneous application of water. **Type of Growing**: PI can be applied to a broad range of growing: Maize and Potatoes in northern Europe, including vegetables, fruits, vineyards and cotton in southern Europe.	**Absence of, or inefficient, water pricing**: water pricing is not at the debate for most of the European regions. Water pricing affects water uses only for a few regions where irrigation water is in demand. **Lack of Subsidies**: In Southern Europe subsidies are not high enough to overcome the financial constraints for the adoption of PI. In Northern Europe, financial factors are not significantly limiting adoption. **Lack of compliance with rules**: low levels of regulatory clearing in some EU regions affect the effectiveness of policy initiatives.

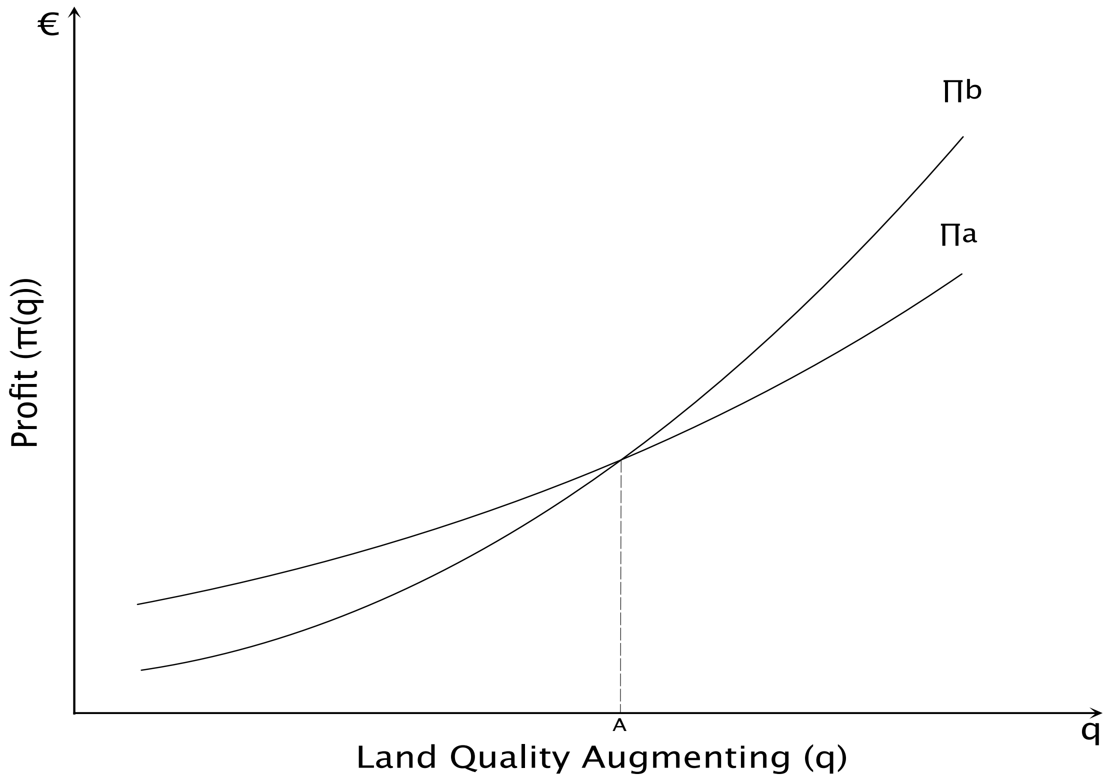
1° step – Delphi study Results

Some policy suggestion to overcome the main barriers for the adoption of PI [SWOT W-T]

BARRIERS	POLICY SUGGESTIONS
Absence of incentives	Targeting specific policy measures that enhance the uptake of PI in those regions where the status of water bodies is compromised (combining direct/indirect subsidies, water pricing, rules of use, etc.).
Low PI usability	Investments in research aimed at increasing the ease of use of crop growth models and in-farm monitoring tools.
Low levels of networking and absence of extension services	Development of advisory services for supporting farmers in using PI and promoting farmers' networks (capacity building) to contrast farmer's aversion to innovation.

1° step – Delphi study Results

Profit trends with land quality augmenting for both conventional irrigation technologies, ∏a, and precision irrigation, ∏b [SWOT S-O]



Authors' own elaboration based on Miranowsky, 1993

2° step – An empirical excercice for the assessment

Value of Information (VOI)

IMPLEMENTATION – Empirical example based on crop growth and water balance model rules

TYPE OF CROP – Processing Tomato

TYPE OF IRRIGATION SYSTEM – Drip irrigation

LOCATION – Mirandola (MO)

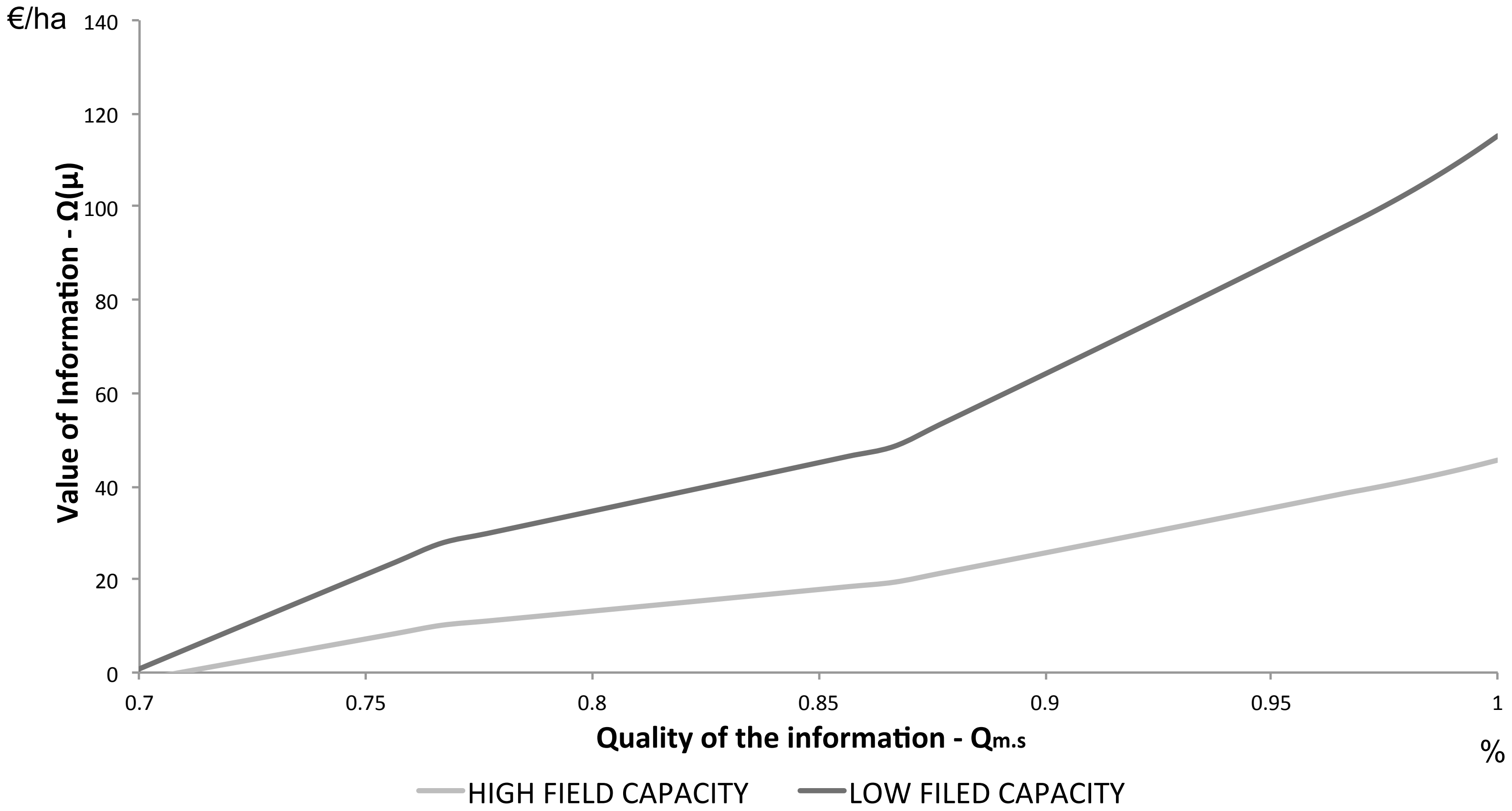
DATA – 1) Historical series of climatic data from the past 20 years (www.arpa.emr.it)
2) Estimation of the production function with respect to water uses for soils with different field capacity (www.fao.org/nr/water/aquacrop.html)
3) Gross margin estimation (www.rica.inea.it)

ASSUMPTIONS

1) The farmer is a risk neutral profit maximizer
2) Farmer's prior expectation about future events are conditioned by the hystorical climate condition of its region
3) The accuracy of traditional nonsite-specific rain forecast is about 60% (www.forecastadvisor.com)

2° step – Assessment results

Farmer's willingness to adopt PI, Ω(μ), with increasing quality of information, $Q_{m.s}$.



Conclusions

PI is considered to be a promising innovation for irrigated agriculture in Europe because:

1) can be applied to any type of irrigation system and in any region of the world

2) it facilitates the accomplishment of current policy tasks (new CAP reform)

However, as addressed in the first part of the study the adoption of PI is strongly conditioned by the environmental, economic and regulatory framework of a region.

For those region where the adoption of PI s considered profitable for both the production and the environment, a set of policy initiatives must be undertaken to overcome any barriers: 1) Research; 2) Advisory services; 1) Direct incentives

Conclusions

FURTHER RESEARCH IS REQUIRED TO:

a) narrowing simulation with empirical evidences

b) determine if and for which type of regions/areas the diffusion of PI could be considered a valuable instrument for the achievement of env. goals

c) determine for which type of users the adoption of PI is more likely to ensure economic benefits

d) determine which type of econ. and reg. instr. are more likely to guarantee the adoption of PI and the expected impact on the environment and on the farm economy

Thanks for your attention

Francesco Galioto
francesco.galioto@unibo.it