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Article: ***Multi-Purpose Technologies***

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1. Moon Base and the Italian Contribution

Space has always been a perfect environment for the development of enabling technologies in a number of sectors.
In the past the concept of multi-purpose has been associated to dual-use one, i.e. military and commercial.

The dual-use approach has been valid in the past in several domains, such as:

- ✓ Remote Sensing
- ✓ Ballistic Missiles
- ✓ Biotechnologies
- ✓ Satellite communications
- ✓ Navigation systems
- ✓ Thermal protections

In 1926 K. Tsiolkovsky defined the sixteen steps for human expansion into space.
Many of them have been reached, but most of those related to the implementation of a viable ecosphere (plants growth, food production in space, etc.) are still to be achieved, while absolutely necessary for Space colonization.

Space exploration is expected to be a multi-national adventure, where system activities will be defined at International Agreement's level.
Italian contribution to this adventure could be relevant to technologies for the development of an ECLSS (Environment Closed-Loop Life Support System).

Relevant technologies would be mainly related to:

- ✓ Zero – Environmental Impact cultivation systems
- ✓ Fully Robotized cultivation systems
- ✓ Advanced Materials and Structures
- ✓ Recycling and Food Treatment equipment
- ✓ Technologies for Environment Protection

2. "Agrospace" Economics

All technologies developed for an ECLSS would refer to the establishment of Space agriculture, from now on called Agrospace.

Agrospace could represent the melting pot between agronomics and space research introducing the best technological innovations on:

- ✓ Cultivation techniques
- ✓ Automation
- ✓ Food treatment and conservation
- ✓ Logistics

for both space and ground applications.

Currently the Italian agriculture, although its direct Value Added to GNP is only third in ranking with respect to Industry and Services, still employs 1,300,000 people and is made up of 2.2 million of organizations.

Whilst the Value Added is relatively small, if we consider the Agricultural enlarged sector, the table below shows the high leverage factor (between 6 and 7) on the overall industrial chain:

Component	(€ M)
VA from Agriculture	30,797
Intermediate Agricultural Consumption	15,335
Commerce and distribution	67,193
VA from food industry	24,873
VA from catering industry	30,443
Indirect taxes in the agrifood sector	10,381
Production subsidies	1,176
Agri-industrial investments	16,279
TOTAL	***196,477***

Source: INEA

Agrospace investments could foster the development of new food growth techniques in conjunction to those known as "organic" or "biologic".
Agrospace new technologies impact on the organic food market could be dramatic, considering the very promising market data of this latter.

The organic food main data are the following:

Business (Turnover) - 2002	1,600 M€
Italian consumption	970 M€
Production (tons)	1,800,000
Avg. Selling Price Premium	30%

Italy - Source: APAT

Currently market growth rate is at 15% and it seems like a substitution rate (average age of the consumers is below 45), such as in any major consumer product technology change.

Giving a look to the world situation, data are similarly impressive:

USA	12 B€
Europe – EU	10 B€
Canada	1 B€
Europe – Extra EU	0.8 B€
Others	1.2 B€
Total	**25 B€**

with a 2002 growth rate set at 10%.

3. Technology transfer: Zero-Impact cultivation technologies

ECLSS technologies will make extensive use of NFT (Nutrient Film Technique)/Aeroponic cultivation methods and will represent one of the most outstanding fallout on earth if implemented on large scale cultivated areas.

Soil-less NFT technologies allow significant savings in terms of:

- ✓ water consumption
- ✓ waste production
- ✓ use of fertilizers
- ✓ energy

Currently in North America 95% of greenhouse vegetables are grown in water (hydroponics).
NFT is much less labor intense and much more capital intensive than current technologies.

Main benefits are:

- ✓ Quality
- ✓ Increased yield
- ✓ Elimination of herbicides
- ✓ Reduction of pesticides

Increased yield
NFT systems vs. traditional field cultivation techniques on vegetables

- ✓ 20-25% increased productivity (tomatoes)
- ✓ Yield increase (pounds)
  - × Tomatoes/acre: 500,000 vs. 60,000
  - × Cucumbers/acre:200,000vs.10,000

Energy savings/Pesticides savings
Energy needed to produce fertilizers for 1 year production of 1 ha amounts to 7,500 kWh. (source University of Florida),
2002 Italian cultivated surface was 15.08×10^6 ha. (with a 8,7% share of organic agriculture).
A realistic case study could be to consider as a target 5% of "Agrospace" (NFT) cultivated surface in the medium term.
This would correspond to 5.65×10^9 kWh yearly saving and an economical value of € 226 M of savings.

NFT Market assessment

NFT technology cultivation areas are spread throughout the world:

	Area (acres)
Americas	5,870
Israel	30,000
Holland	10,000
England	4,200
Asia	8,000
Total	***58,070***

The Italian agricultural output is given in the following table:

Component	**Output (€ M)**
Cereals	5.56
Vegetables	6.60
Industrial crop	1.15
Flowers and ornamentals	2.44
Grapes	3.43
Olives	2.07
Fruit	3.99
Others (Fodder crops, milk, …)	16.50
TOTAL	***41.74***

Source: INEA

And the reference market for Agrospace products can be assessed (Vegetables, Flowers and Ornamentals) at 9 Millions €.

Considering the effect of the leverage factor the enlarged Italian Agrospace market can be assessed at 60 Millions € a year.

4. Our hope

Hope of Italian industry is that ***Italy will sizeably join US space exploration efforts***.
The most promising way to bring a contribution to the Space Exploration Plan could be characterized by the ***provision of an agreed, integrated and self-standing subsystem***.

This could be supported by a ***Buy Italian procurement policy*** to promote a National system approach, where a ***significant participation*** of non-space and small-medium size enterprises is foreseen.

5. References

"Italian Agriculture in Figures 2003", Istituto Nazionale di Economia Agraria
"Conti Economici Nazionali 2002-2004", Istituto Nazionale di Statistica