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Reports of the workshops:

SmartGrid for Food Systems - Anacapri 2017
SmartGrid for Urban Food Systems - Bari 2019

WG FOOD

Science and Technology Foresight: from society to research
National Research Council of Italy

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FORESIGHT

from society to research

Workshop:
SmartGrid for Food Systems

Applying emerging technology to build resilient nutrition supply networks

3 - 5 May 2017, Anacapri, Island of Capri, Italy

WG FOOD

National Research Council of Italy

Science and Technology Foresight Project
National Research Council of Italy (CNR)

www.foresight.cnr.it

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National Research Council of Italy

Science & Technology FORESIGHT from society to research

"Converging technologies for Sustainable and Healthy Food"

2nd Workshop: SmartGrid for Food Systems

03.05.17 – 05.05.17
Anacapri, Island of Capri, Italy

Wednesday, May 3

15:00 Presentation of the Foresight Project Ezio Andreta
15:10 Workshop methodology and goals Giorgio Einaudi
15:20 Introduction to the concept of the "SmartGrid for Food Systems" Cecilia Bartolucci

TOPIC 1: Small farmers' fruit and vegetable production in Italy

15:30 PRESENTATION 1. Biodiversity and vegetables production in Puglia, Italy. Francesco Montesano, CNR-ISPA (10 min)
Questions and Answers (Q&A) (10 min)
15:50 PRESENTATION 2. Integrated systems approach to fruits and crops production in Emilia Romagna, Italy.
Maria Grazia Tommasini, CRPV
Q&A
16:10 PRESENTATION 3. Title t.b.c. Megan Bettilyon, Intellectual Ventures
Q&A
16:30 Topic 1 Plenary Group Discussion
17:30 Coffee Break
17:45 Topic 1 Break down sessions (4 inter-disciplinary groups of 10-12 participants)
20:00 Dinner

Thursday, May 4

9:00 Topic 1 Report Group Discussions; Plenary Discussion

TOPIC 2: Urban agriculture in the US

10:00 PRESENTATION 4: Urban precision agriculture. Nilofer Ahsan, Institute for Transformative Technology, USA
Q&A
10:20 PRESENTATION 5: Boston: a hub/spoke model for urban agriculture JoAnne Shatkin, Vireo advisors LLC, USA,
Q&A
10:40 Coffee Break
11:00 Topic 2 Plenary Group Discussion
12:00 Topic 2 Break down sessions
13:00 Lunch
14:30 Topic 2 Report Group Discussions; Plenary Discussion

Topic 3 Impact of social and climate change

15:30 PRESENTATION 6: Impact of social and climate change on rice production in Senegal. Vieri Tarchiani Institute of Biometeorology CNR-IBIMET, Italy; Mame Ndella NGOM,Italian Agency for Development Cooperation Dakar
Q&A
15:50 PRESENTATION 7: Technology transfer to corn production, from Mexico to Kenya.
NataliaPalacios, CIMMYT, Mexico,
Q&A
16:10 PRESENTATION 8: Tourism challenge on small-scale agribusiness in Bali.
I Made Utama Supartha Udayana University UNUD, Indonesia
Q&A
16:30 Coffee Break
16:50 Topic 3 Plenary Group Discussion
17:50 Topic 3 Break down sessions
19:30 Dinner

Friday, May 5

9:00 Topic 3 Report Group Discussion; Plenary Discussion
Plenary Discussion SmartGrid
10:15 Break down sessions on SmartGrid
11:15 Coffee Break
11:30 Plenary Discussion, Closing remarks
13:00 Lunch

National Research Council of Italy

Science & Technology FORESIGHT from society to research

Workshop Announcement

Anacapri, Italy, 3-5 May 2017

SmartGrid for Food Systems

Applying emerging technology to build resilient nutrition supply networks

The concept of "SmartGrid for Food Systems" arose during the 1st Foresight Workshop on "Diverse Adaptable Food" (see foresight.cnr.it), from the need to propose a new approach to the challenge of providing, in a sustainable way, food security and healthy food to a growing population. Malnutrition is prevalent in many parts of the world and predictions are that it will get worse as the population grows. However, there are estimates that caloric production capacity today could easily meet the need in 2050 if we could only match capacity and nutritional quality to the need. Much of the mismatch is because of a wrong quantity/quality ratio, or because areas of need are separated from areas of production. Technology has the potential to allow much more capacity to be produced nearer to the areas of need, supporting local realities and variations (crops, climate, population, culture) according to specific demands. In this framework a further challenge comes from the effects of global climate change, with the related impact on the availability (in terms of both quality and quantity) of the water resources needed for drinking purposes and food production. Water equity and trade is expected to be a major issue in the coming decades, with significant effect on health, food availability and well-being, and cannot be kept separate from food production.

Adapting local and regional variation in resources and capacity to local and regional need through a smartgrid, will create diversity and resilience in nutrition supply and can reduce water and energy needs, loss and waste production. Diversity comes from local variation connected to regional and global markets. Resilience comes from networked supply lines to diverse capacity reserves in local, regional, and global networks. Waste reduction and energy savings come from focused application of new energy and water technologies and supply networks that reduce transport and post-harvest loss of yields.

A smartgrid system for nutrition production and supply can be developed by focusing existing and emerging technologies to match capacity and need while balancing resource use in diverse geographic, social and economic conditions.

Benefits of this approach are:

- efficient use of supply chains and capacity
- resilience and sustainability
- distribution of markets and capital flow
- focus for socially beneficial technological growth

Within this frame, the Foresight Group is organizing a workshop on **"SmartGrid for Food Systems"** to be held on **3-5 May, 2017, Anacapri (Italy)**. Goal of the workshop is to validate the concept of SmartGrid for Food Systems and to indicate processes and technologies which, in a long term, allow its realization. (For background documents, more details on the Foresight Project, and the methods adopted by the Foresight Group see foresight.cnr.it)

SmartGrid Criteria

A **food system** is defined as a system that embraces all the *elements* (environment, people, inputs, processes, infrastructure, institutions, markets and trade) and *activities* that relate to the production, processing, distribution and marketing, preparation and consumption of food and the outputs of these activities, including socio-economic and environmental outcomes. (HLPE (2014), Report: Food losses and waste in the context of sustainable food systems.)

This definition does not include the variable size (geographical, economical, variety of products or amount produced …). Hence, we can talk about local, regional, inter-regional, or global food systems; a food system responsible for the production of only one product (e.g. apples in South Tirol, Italy; rice in Senegal …); or a food system focused on producing food for a specific area such as urban areas. It is fundamental that, whenever we talk about a food system, we consider all elements and all activities as described in the definition above. A food system approach considers also that all food systems are part of the global food system and hence interlinked. The "SmartGrid for Food Systems" exploits this interconnection to create a more balanced, resilient and sustainable global system.

The focus is set on the local food systems (i.e. the local nodes of the smartgrid), and their potential to match local needs to local resources. Local systems are connected to the regional and inter-regional systems (further nodes in the grid) in a dynamic and flexible way. At all levels (from local to global), systems within the grid need to fulfill the following criteria:

- Match supply and variety to needs
- Optimize resource use, both in terms of efficiency and sustainability
- Support agricultural ecosystems and ecosystem services

Fulfilling these criteria while ensuring food security and healthy nutrition can be achieved only through:

- The monitoring and evaluating of local and regional key supply chain data regarding nutritional need, production capacity, and nutritional quality and quantity
- The connection of capacities and needs through a local, regional, and inter-regional distribution network
- The connection of different nodes through monitoring and predicting the smartgrid response to future climatic, environmental and socioeconomic conditions.
- The adaptation of production methods and technologies to resources (locally, regionally, inter-regionally)

This is conceivable though improvements in agriculture and integration of emerging technologies for food production and processing, materials to process and store food, and technologies for energy and water. New knowledge in the relationship between health and nutrition followed by the development of proper technological applications will also need to be addressed. Furthermore, infrastructure to shorten and optimize paths from production to need can also work in the reverse direction to connect local capacity to regional and global markets and thereby reduce barriers to participation in markets.

SmartGrid for Food Systems

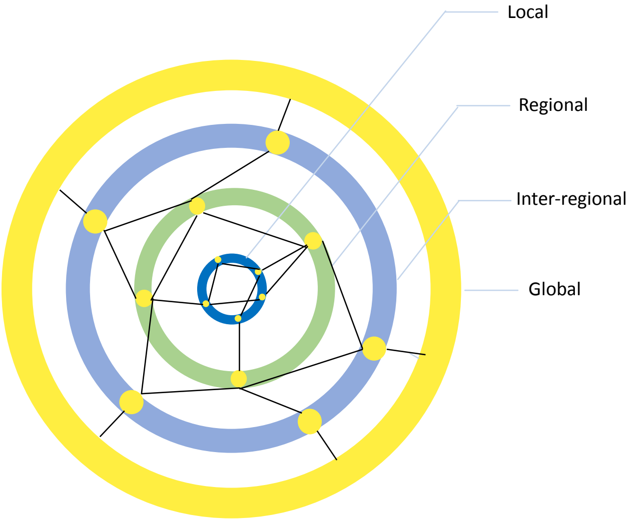
● Represent the different food systems/nodes of the grid

Each **food system** should:

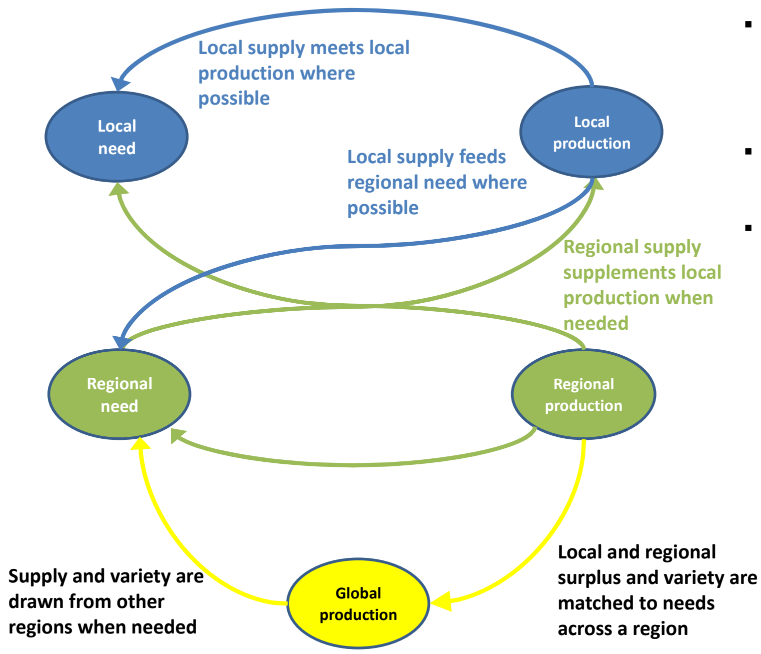
- Match supply and variety to needs
- Optimize resource use
- Support agricultural ecosystems and ecosystem services

The **smartgrid** interactively supports at all levels:

- Monitoring key supply chain data (nutritional need, production capacity, and nutritional quality and quantity).
- Connecting capacities and needs



The Food System grid is complex, unstructured, and the nodes vary in a dynamic way. Acting on one node influences the status of other nodes and above all, it influences the global condition. The inputs for the necessary actions required to achieve the functioning of the grid come alternatively from different nodes, according to changing situations and current realities. The management and success of the grid is possible only through its being able to gather data and act on them, eventually in a predictive way. Hence, the grid needs to be smart. New technologies need to be developed to allow the rapid exchange of data as well as to enable searches to be made through the grid in a fast and efficient manner.



- **Optimize supply chain length to match local production on regional and inter-regional scale**
- **Match surplus and variety to needs**
- **Capital flow can extend to and from local nodes.**

Building case studies

1. Goal of the case studies

Case studies will provide a base for the discussion during the foresight workshop and are the bridge between the current situation and the development of a smartgrid in the long-term future. We are currently choosing three thematic case study groups, relative to three different food systems challenges. Within the same group we will propose at least two separate case studies. To facilitate coordination and collaboration, single case studies within a thematic group will be carried out in the same region/state. This will also facilitate the connection of food systems within a group. It is important to remember that this is a foresight exercise, hence the unanswered questions rising from the case studies are those we are most interested in. We want to identify gaps and barriers preventing the realization of resilient nutrition supply networks and point out to technologies to overcome them.

Themes for the case studies:

- Small farmers' fruit and vegetable production in Italy: one case study will be on integrated production of fruit in Emilia Romagna and South Tyrol, a second case study on vegetable production in Puglia.

- Urban agriculture in the US: we have contacts with groups working on urban agriculture in Berkeley, Boston.

- Impact of climate change on crop production: in Bali we want to carry out case studies regarding the impact of climate change and social change, e.g. tourism, on agricultural production. A second case studies will regard rice production in Senegal.

The themes for the case studies are different, yet when integrated into a food system approach, they are related to each other. Each food system analyzed in each case study represents a node in the grid. Evaluating ways of connecting the nodes represents the first step in creating the grid itself.

Before the workshop, we need to describe and map the single food systems, addressing strength and criticalities of the current approach. Furthermore, we want to have proposals on how these systems could be optimized through their integration into a smartgrid. In order to do that, we want to point out technologies that need to be developed and/or integrated to allow a smartgrid system to be created.

A concise report of the case studies will be provided to all workshop participants prior to the meeting. Specific challenges and highlights of each single case study (or case study group) will be briefly introduced during the workshop. A group of scientific multidisciplinary experts, representatives of governmental institutions, industries, policy makers, and NGOs, will evaluate the proposals and discuss their applicability, pointing out priorities and knowledge gaps that need to be filled.

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The vegetables local varieties in Puglia (Italy): a legacy from the past and a heritage for the future

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1. Summary

The case study focuses on the role that production and consumption of "traditional vegetables" play in the vegetables food-system in Puglia (Southern Italy).
Puglia, a leading region for intensive horticulture, boasts an enormous heritage of local vegetable varieties, whose cultivation is still widespread and well established in response to demands of local, international and high gastronomy markets, based on their higher quality and the associated socio-cultural implications. However, a significant part of this agro-biodiversity has been lost in the last fifty years, and the threat of continuing to lose it in the future is serious.
Traditional vegetables complement the production and the supply of conventional ones, in a much-diversified scenario of production and consumption styles, representing an example of agro-biodiversity protection and cultivation practices calibrated on the characteristics of Mediterranean environments.
Policy makers are investing resources in the protection and enhancement of agro-biodiversity, involving research institutions and promoting actions addressed to seed-saver farmers and consumers.
The commercial value of these products is supporting forms of associations between producers, favoring the creation of brands and facilitating the consumption of local products.

2. Introduction

The concepts of biodiversity, of its progressive loss and the need to protect it, are now rooted in the scientific and policy makers' community. These concepts are gaining more and more place also in ordinary people. According to a survey on attitudes of Europeans toward biodiversity, at least eight out of ten Europeans consider serious the various effects of biodiversity loss. However, although the majority of Europeans have heard of the term "biodiversity" (60%), less than one third (30%) know what it means, and most do not feel informed about biodiversity loss (66%), and think the EU should better inform citizens about the importance of biodiversity (93%) (1).
In the general framework of the biodiversity issue, which in most cases refers to natural ecosystems, the concept of 'agro-biodiversity' is arising a lively interest. According to the FAO definition (2), agro-biodiversity is a vital sub-set of biodiversity, and refers to the diversity in agro-ecosystems. It comprises the diversity of living organisms and genetic resources (cultivated species, varieties, breeds; wild flora; soil microorganisms; predators, pollinators). Agro-biodiversity is the result of the interaction between the environment, genetic resources and management systems and practices, encompassing the variety and variability that are necessary for sustaining food production and food security. Therefore, local knowledge and culture can be considered as integral parts of agro-biodiversity, because the human activity of agriculture is the one that shapes and conserves this biodiversity.
Intensive agriculture has generally resulted in higher productivity, but also in a trend towards decreasing levels of agro-biodiversity. It has been noted that the so called "green revolution" in agriculture, with its modern scientific approaches to plant breeding, represented a biodiversity narrowing phase. It replaced genetically diverse landraces and local varieties, selected over centuries and representing an incredible heritage of diversity, with uniform varieties like hybrid F1 in vegetables (3, 4). During the last century, almost 75% of local varieties have been lost, but this percentage may rise up to 90% in USA. Modern varieties are conceived to meet the requirements of market, processing industry and modern distribution. At the same time, they are subjected to rapid obsolescence.
The preservation of agro-biodiversity represents a key-point to assure adaptability and resilience of agro-ecosystems to the global challenge we will be facing in the near future, namely to produce more and better food in a sustainable way. While many components of agro-biodiversity would not survive without human interference, human choices may also represent a threat for the agro-biodiversity preservation.
In this case study, we present the role that vegetables local varieties play in a very intensive agricultural region, Puglia (Italy), where the food culture of the people is characterized, probably more than in other places, by the use of traditional

vegetables, and efforts are being made to exploit this incredible richness.

3. Case Study

The region of Puglia is located in the southeastern part of Italy. The area is approximately 19.000 km^2, almost flat or hilly, and the population is ≈4.000.000 people. Puglia has a typically Mediterranean climate with temperatures that may fall below 0 °C in winter (in the northern part or hills) and exceed 40 °C in summer. Annual rainfall ranges between 400 and 550 mm, mostly concentrated during the winter. Mediterranean region is considered highly interested by climate change in future scenarios, by both increasing temperatures and by changes in the frequency of extreme climatic events. Thus, concerns for impacts on agricultural production are now under the spotlight in Puglia, with a particular reference to irrigation water management issues (5).

Due to its climatic conditions and land characteristics, Puglia is one of the most important regions in Italy for the vegetables production, accounting for ≈21% (≈92.000 ha) and ≈24% (≈3.261.000 tons) of the total open air growing area and amount of vegetables produced at national level, respectively. The region is among the leaders for the production of several vegetable crops such as broccoli and cauliflower, celery, parsley, processing tomato, artichoke, endive and escarole, cabbage, fennel, lettuce, cucumber, early potato and asparagus. The vegetables production industry accounts for about 30% of the total economic value of regional agricultural sector. About 8.000 ha of the regional vegetables growing area are interested by organic cultivation systems, representing the 30% of the total national organic vegetables cultivation (6).

In a recent analysis (4), it has been outlined that there is a general mismatch in Europe between the areas in which agricultural production actually occurs and areas with the highest activity of the seed industry. In fact, The Netherlands, which represents only ≈5% of the total production of vegetables in Europe (7), has an absolutely predominant position in terms of number of commercial vegetables varieties and hybrids released and registered in the Common Catalogue, with specific characteristics (high yield, genetic resistance to pests and diseases, long shelf life, processing industry requirements, ...). On the other hand, Italy, accounting for ≈18% of total Europe vegetables production, has registered a number of varieties absolutely not comparable with The Netherlands. In addition, at national level the predominant position of Puglia, in terms of vegetables production industry, does not overlap at all with its position in the seed industry (less than 2% of commercial vegetables varieties registered in the national register are from companies located in the region).

However, Puglia represents an example of how local vegetables varieties can still strongly interact with modern horticulture in defining a complex food system, in which local culture and traditions are interconnected with local productions and local environment. In fact, the region is particularly rich in local vegetables varieties and some of them are still largely used and requested by the population. A local variety *"is a population of seed- or vegetative-propagated crop characterized by greater or lesser genetic variation, which is however well identifiable and which usually has a local name ... has not been subjected to an organized program of genetic improvement … is characterized by a specific adaptation to the environmental and cultivation conditions of the area where it has been selected … is closely associated with the traditions, the knowledge, the habits, the dialects and the occurrences of the human population that have developed it and/or continue its cultivation*" (4).

Although even in Puglia, similarly to what happened at global level during the last fifty years, a strong loss of agro-biodiversity was registered, in this region, a consistent number of local vegetable varieties can be still identified. In many cases, these vegetables are affected by a serious risk of erosion, since their cultivation and seed production is committed to a few farmers, who grow them on very limited areas, often in family or amateur gardens. In other cases (see below), fortunately still numerous, we can observe professional production and real economic value of these vegetables, and the important role played by social mechanisms at the basis of the match between supply and demand for vegetables at local level.

Over the last decade, numerous actions have been undertaken at regional level for the protection and the enhancement of this incredible richness. These imply the involvement of research institutions, including the University of Bari and the CNR along with several others, and an increasing number of farmers interested in preserving and promoting the recovery, characterization and preservation of these varieties, under the coordination of the regional Authority. The activities aimed to classify and characterize the vegetable varieties still present on the territory, to recover seeds, to study them under the genetic, socio-cultural, horticultural and nutritional profiles, and to initiate actions of protection, as the *on-farm* conservation. In particular, in the framework of the BiodiverSO project (http://www.biodiversitapuglia.it), 122 local varieties belonging to 31 species of vegetables still cultivated in Puglia were identified (this number is likely to double by the end of the project in October 2017). For most of these varieties there is no track at official level, and their extinction risk is related to not having been subjected to targeted research and preservation programs for decades. Strategic importance had the creation of the position of ''seed-saver farmer", officially recognized from regional authorities as a key-figure for the preservation and exploitation of agro-biodiversity.

Here we report just a few examples of important traditional local vegetables. With approximately 4.200 ha, Puglia holds the absolute primacy in the world for the cultivation of broccoli raab ('Cima di rapa').

Despite the crop being widespread all over the region - and a huge diversity of local varieties differing for earliness, habit of the plant and specific characteristics of the inflorescences -, no varieties are registered in the Italian or European Register of commercial vegetables, and the propagation is committed to local farmers and to a few local seed companies (4). This vegetable is present on the tables of Puglia inhabitants from September to May with a high frequency, consumed alone or with pasta. Homemade 'orecchiette' (a typical size of pasta) with 'cima di rapa' is a flag of the Puglia cooking tradition in the world.

Another valuable example of traditional vegetables

is represented by the landraces of immature melons ('Carosello' and 'Barattiere' are the local names of the two major groups of these landraces, largely consumed in Puglia and generally preferred to common cucumber). The local varieties are usually named according to the town or the area of cultivation, and are different for the shape, color and flavor of the fruits. No local varieties have been subjected to organized programs of genetic improvement, and no official statistics on the diffusion of these vegetables are available, but it is estimated that a growing area exceeding 500 ha is present in Puglia, both in open field and under greenhouses. The consumption and the market is prevalently local, but we are aware of growers who are getting into the great-organized distribution, and the product is now getting popular also in Northern Italy.

The Polignano carrot ('Carota di Polignano', from the name of the little town where it is cultivated in

a growing area of about 20 ha), is characterized by a special sweetness, crispiness and fragrance and by a great variety of root colors ranging from yellow to deep purple. It is appreciated in the area surrounding the town and can be commonly found in the local markets of the near city of Bari (≈320.000 inhabitants). This product is preferred to common hybrid carrots and on the market, it can achieve much higher prices. Local landraces of colored carrots are also getting into the great-organized distribution.

A relevant example is represented by the artichoke cultivation in Puglia. About 15.000 ha are covered by not officially registered artichoke local varieties. The BiodiverSO project contributed to develop advanced techniques for production of virus- and fungi-free artichoke transplants, and the local nursery industry is more and more able to match the increasing demand of safe propagation material.

Research teams are approaching the valorization of these varieties with advanced horticultural and food sciences tools and expertise. The technologies now available can be used to prevent mistakes made in the past, when traditional varieties were substituted by new ones, often without a proper verification of the opportunity of this action. We found that these traditional products generally have higher nutritional value than common commercial varieties, in which the content of nutritional compounds has often been reduced because of increased yield or longer shelf life. The adoption of modern horticultural techniques (soilless greenhouse cultivation systems, use of DSS, new approaches to fertigation, grafting, etc.) can be used to improve crop performance and resources use efficiency of local varieties. It has been proven, that local varieties are also particularly suited to organic cultivation. New scientific techniques (i.e. Genotyping By Sequencing - GBS) are revealing the incredible genetic heritage value of these local varieties (8).

The cultivation of local varieties is so strongly connected with traditions and gastronomy, as well as with cultivation practices aimed at the preservation of resources, especially water, in this semi-arid environment (aridoculture), to be considered a subset of the agro-biodiversity. Vegetables consumption is one of the pillars of the Mediterranean diet, and vegetables contribute substantially to nutritional benefits of this diet. Typical cooking recipes, methods of conservation and processing are deeply linked to the life-style of people in Puglia. There is a renewed interest in recovering traditional products with modern approaches and technologies. The target is mainly local, since traditions contribute to the definition of local needs, but high value products can be exported out of the regional borders. The use of traditional vegetables varieties is a part of the new 'sustainable cooking' concept, and there are international examples of how the food culture of Puglia can be framed in this concept (http://www.antonellaricco.com/).

Taking into account the challenge to produce better food in the framework of a modern horticulture, the need to face the threats of climate change and the reduced availability of resources for agriculture, as well as the objective to define more sustainable agro-ecosystems, and to preserve the link with our traditions, we consider that the genetic resources represented by vegetables local varieties are an inestimable richness, to be protected and better used.

If we consider the increased consciousness on the importance of local varieties, and the initiatives undertaken by the scientific community and the policy makers, it is likely that their preservation and exploitation will be enhanced in the near future. However, preservation of agro-biodiversity should imply the empowerment of all the players of the food system, including consumers, whose needs are at the center of the food system concept. An enhanced and modern distribution of these products, the adoption of sustainable growing techniques, the demonstration of benefits for growers who will chose local varieties, are some of the key-points for future scenarios.

8. Conclusion

The crop diversification, also based on the use of local varieties, is now considered a prerequisite for food security (9). The smartgrid for food system criteria include the need to match capacity, supply and variety to needs starting from local systems, to optimize resources use, both in terms of efficiency and sustainability, and to support agricultural ecosystems and ecosystem services. The human being, with his traditions and knowledge heritage, is at the center of the system. The preservation and the exploitation of agro-biodiversity, in terms of genetic inter- and intra-specific diversity and background of local traditional knowledge, implies several points of connection whit this new approach to food systems. Efficient use of resources cannot exclude the genetic resource represented by local varieties, a key-point to increase the adaptability and the quality of new cultivated varieties.

Local varieties cannot be proposed at the moment to substitute modern varieties, better performing and suitable to the current production and market conditions, but it is necessary to begin now to meet the consumption styles and needs of an increasing part of the consumers, in order to promote and consolidate their use. However, the smart grid vision for food system implies a radical change and a new paradigm for the food system, so it is likely that local varieties could be highly suited to the new conditions, because closer to the concept of local production, to the cultural heritage of territories and because generally more nutritious.

New growing techniques and advanced technologies supported by research activity could be used to overcome the gap with modern varieties. The empowerment of people is a key-point for an effective enhancement of the current food system. All actions aimed to increase knowledge and responsibility of people on agro-biodiversity theme, will increase the sustainability of agro-ecosystems. To gain the highest benefit, we need to enhance with modern approaches all levels of this food system (seed industry, growing, post-harvest and processing, distribution and market, marketing, involvement and empowerment of people). We should get back … to the future!

9. References

(1)*http://ec.europa.eu/COMMFrontOffice/publicopinion/index.cfm/Survey/index#p=1&search=biodiversity(03/31st/2017) (03/31st/2017)*

(2)*http://www.fao.org/docrep/007/y5609e/y5609e01.htm#bm1 (03/31st/2017)*

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(4)*Italian Journal of Agronomy, 8(1),4,2013.*

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(8)*BMC genomics, 18(1), 59, 2017*

(9)*PNAS, 111, 4001–4006, 2014.*

The Integrated Production system in Emilia Romagna region (Italy)

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1. Summary

The Integrated Production (IP) in Emilia-Romagna began over 30 years ago, starting from the need of a better environmental sustainability, followed then by an improved quality of agricultural productions. Initially, attention was paid to crop protection while reducing pesticide use and it was called "Guided control", and later "Integrated Pest Management". Now the concept has been enlarged with IP considering all crop production processes, that is, integration of all agronomic, physical and chemicals means for crop management, in order to reduce the input and have minimum impact on environment and human health. The strength and specific element of this Production System is represented by the IP Guidelines (IPG) developed for all crop species grown in the region (over 90)(Figure 1).
The current goal, in particular for fruit and vegetable crops, is the Sustainable Production, which means an even higher qualified production, addressing much more attention to e.g. human health, food safety, intrinsic quality of the products, and respect for the environment.

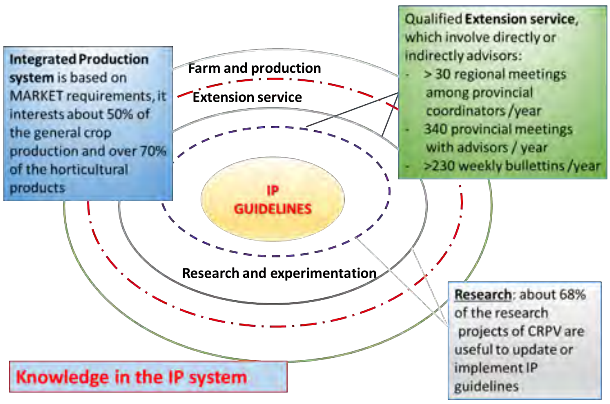

Figure 1

2. Introduction

The main elements describing the system taken into consideration, are briefly described below:

- An intensive farming system. Important presence of fruit crops (pome and stone fruit), for which the region has a nationwide predominant position, viticulture, industrial vegetable systems (potatoes, tomatoes, green beans, spinach, etc.), and cereal.
- The farms, usually family-run, are small to medium in size (<15 ha) with a slow generational turnover.
- Presence of an extensive cooperative system. Cooperatives of producers collect, and in some cases process, the product provided by members. They keep the product marketable and offer a good level of services, including extension service (about 600 advisors are active in the region), to their members (farmers).
- Through binding standards or recommendations, IPG define for each crop the most suitable cultivation techniques (from soil preparation work, phytosanitary control, fertilization and irrigation, until harvest, storage or conservation of the products) combining in a synergistic way agronomic, biological and when necessary chemical systems/techniques
- The region supports the network of extension service by partly-financing a system of coordination, from regional to provincial/local level, through the involvement of the different regional districts.
- The IPG are applied by farmers to all crops in the farm in order to benefit from public economic incentives related to environmental impact, and also to facilitate positioning of products, responding to requirements of supply specifications, in particular of large retailers and of the market (internal, national and international).
- scientific and experimental institutions provide, through applied research and experimentation, an important contribution, maintaining consistently high the upgrade level of IP.
- CRPV acts as the main link between different scientific institutions, public bodies and the demands of the organized agricultural production.

In Figure 2 diagrams of the actors of the Emilia-Romagna system for the application and support of IP, and the components of the IP system are shown.

All agricultural supply chains in the region participate to integrated production programs, although the vegetable-fruit (horticulture) and grapevine supply chains are the most involved, even historically. This is due to their specialization, obtainable higher production quantities, image advantages (a number of quality labels), and greater marketing initiative of the actors involved. The application of IPG requires high preparation and specialization and its success is due to an efficient advisory system for the farmers. One of the key to the success of IP in the Emilia Romagna region is given by a large network of advisors, mainly belonging to Producers' Associations/ Organizations. Large Supply Retailer (LSR) (Supermarket, Hyper, Discount, etc.) is the main internal market for the integrated production products, although also demand from HORECA (Hotellerie-Restaurant-Café) is growing. A large amount of the production is also exported to international LSR. The demand for organic products has increased considerably, and different eating habits (vegetarian, vegan, raw food, etc.) are growing, affecting food products demand. Furthermore, the need of consumers on spending less time in food preparation brings to an increased demand for fresh-cut products and pre-cooked food.

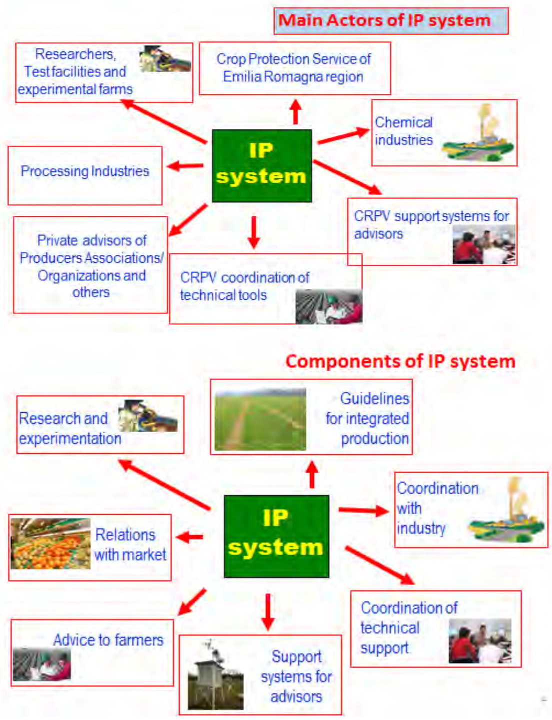

Figure 2

3. Case Study

a) Resource efficiency and sustainability

As mentioned above, the agricultural system in Emilia Romagna, except for the surfaces dedicated to grassland by the dairy industry, is of intensive type, and in particular the one concerning the horticulture production. To guarantee high productions and adequate levels for quality standards, as well as to provide effective control of multiple diseases and pests, a considerable amount of external inputs (e.g., pesticides, fertilizers, fuels for the mechanical operations) were applied for many years. However, in the late '70, their excessive use stimulated thoughts about a new model of agriculture. The result was the integrated production (IP) with an overall knock-on effect to major parts of cultivated areas also outside of Emilia-Romagna, in other Italian regions.

The use of supporting tools (e.g., forecasting models related to the development of fungal diseases and pests) and more advanced technologies (e.g., sensors to evaluate soil moisture, mating disruption techniques to control some pests) are giving a significant contribution to the reduction of inputs, increasing their efficiency and saving valuable resources such as water. The use of renewable energies, such as photovoltaic or electricity, is however still not widespread.

b) Underlying socio-economic realities

Emilia-Romagna is a region with a strong agricultural vocation with over 70,000 farms surveyed and over 1 million hectares of Agriculture Land Use area (ALU), of which IP involves a total of about 170,000 hectares. For some crops, such as processing tomato, the totality of the surface is managed as IP.

As mentioned above, IP application takes advantage in a strong association system (the larger associations of vegetable-fruit growers in Europe are present in the region) and the solid cooperative system from the late nineteenth century. In addition to this relevant rural structure, that resists more or less successfully to the challenges of globalization, in the region there are important agro-food districts with structures of first and second transformation of national and international importance (e.g., Barilla in the cereals sector, Conserve Italia for the horticultural sector, Granarolo for the dairy sector).

Consumer information is generally rather good, at least for certain age groups and levels of education, starting from primary school and continuing over also by the contribution of major supermarket chains (e.g., Coop, Conad, Esselunga) interested in promoting the nutritional aspects and health of their products. Proof of this is also the request of a constant increase of organic products, also by the HORECA system.

c) Correlation of food-production system with food-consumption system.

In Emilia Romagna the consumption of local products, also linked to their seasonal nature, is prevalent and seen as a priority. This is related both, to a cultural perspective and to a link to traditions that have strong roots even in food. Information campaigns and commercial marketing are also supporting this direction, in order to limit consumption of products in counter-season, burdened by long transport, or not guaranteed for their safety and quality. In some cases, also direct contact between consumer and farmer is reinforced, for example by offering “0 km” products in local type markets. This however, is not expected to be considered an extensible solution to large agriculture. In the last few years, a decline in consumption of fruit and vegetables has been detected, presumably due to the general economic crisis, although there is a strong 'Mediterranean' education to the daily consumption of fruits and vegetables, with respect to less healthy foods.

d) Future developments (3-10 years)

It is foreseeable, that the IP system will constantly evolve in terms of the structural aspect of the companies, the market demands and regarding the respect for the environment. Currently it is the word QUALITY (high nutritional value production with good organoleptic characteristics, produced with minimum use of synthetic products) that is driving the agricultural sector. This occurs without penalizing the quantity of production to ensure the economic sustainability of farms. The entry of the new generations in agriculture will allow a higher cultural approach, more familiarity to modern technology, the use of information systems such as precision farming techniques, as well as the use of sensors to guide the decision-making processes. The market now sees the IP almost as a prerequisite for their supplies and, in certain cases, imposes stricter supply specifications, as for example for products intended for children. Moreover, thanks to modern techniques like Life Cycle Assessment (LCA), producers pay also more attention to Environmental Product Declarations concerning greenhouse gas emissions (CO_2 equivalent) and saving non-renewable resources.

e) Proposed actions to address the criticalities and/or strengthen potential (today – 10 years)

Actions to overcome the difficulties and strengthen the potential of the "IP System" can be:

- Strengthening the range of diversified products also including niche products, while maintaining and promoting the typicality and excellence (e.g., Parmesan cheese, pear).
- Strengthening both productive districts and organized supply chains (from production to processing) at regional level.
- Encourage dialogue between scientific institutions and the farmers towards answers to concrete needs on production innovations.
- Strengthen and improve monitoring techniques, supporting tools and decision supporting systems for advisors and expert farmers.

8. **Conclusion**

In a long-term perspective, it is necessary to support and strengthen the actors at the beginning and at the end of the agro-food chain: the farmer and the consumer.

The farmer is currently the weakest actor in the chain, subject to influences of global issues such as climate change and economic aspects (such as the market and consumers). Regarding the farmers, the opportunities to be promoted could be:

i) Maintenance of profitability;
ii) Encouragement and improvement of entrepreneurial skills;
iii) Incentivize technological tools application that fosters a more sustainable production in terms of quality, environmental impact and economy;
iv) Diversification of production also developing culturally more distant approaches/systems, such as organic farming.

The consumer is often referred to as the one that influences the market with trends, tastes, needs. However, often it is in somehow a hostage of the market, partly due to the lack of knowledge on how food is produced in order to make conscious choices. Hence the need to free himself and possibly to influence really the market

Regarding the consumer, the main attentions could be turned to:

i) Food and nutritional needs;
ii) Prevention of diseases and dysfunctions;
iii) Exploitation of values related to tradition, food culture, and territory;
iv) Exploitation of natural and landscape aspects of the rural world (public goods).

To counteract the effects of climate change, which will be the biggest challenge that the agricultural system and thus the IP will have to face, there is a need to think about a model of agriculture that, without giving up the benefits of technological progress, continuously reduces the use of external inputs (with all the side effects that this implies), promotes resilience factors suitably guided by man (increase in plant and animal biodiversity; attention to the vulnerability of soil as well as surface water and groundwater; increase of carbon sequestration and reduction of greenhouse gases emissions; increase in the bio-economy). IP is moving in this direction although it continuously needs upgrade of the techniques and improved technology in order to simplify and keep cheaper the IP applications.

Emilia-Romagna is considered worldwide one of the richest regions of local products (44 products DOP - Protected Designation of Origin and PGI - Protected Geographical Indication) (Fig. 4) with a variety of food and wine districts, hence it earned the nickname of "food valley". The Emilia Romagna fame is mainly due to the Parma ham and Parmigiano Reggiano cheese, renowned all over the world. However, can the resourcefulness (markets, festivals, typical products) that culturally characterizes Emilia-Romagna people, help to promote the agricultural sector, also linked to tourism, and to maintain/improve the integrated and sustainable agriculture and production in future? Sustainable agriculture is an even more advanced perspective of the IP concept and it is based on the principle of an equitable development that would not endanger the livelihoods of future generations: respecting people, planet and profits. Agricultural policies represent another important aspect that supports the Emilia Romagna IP system as well as the systems in many other Italian and European regions. Will such policies adequately support and improve the current system and grow with it to accompany it in the future?

New generations of farmers must receive assistance in order to increase productivity, and reduce hard labor and negative environmental impact. The challenge is not to maintain traditional production, but to protect tradition by combining it with the greatest advances in science on order to create truly sustainable systems, that meet the majority of our goals. What these systems look like will depend on ecological and economic circumstances. However, resources such as water, land, and labor must be used efficiently, and waste, such as by-products of agriculture at harvest and processing stages, must be reused in the food chain.

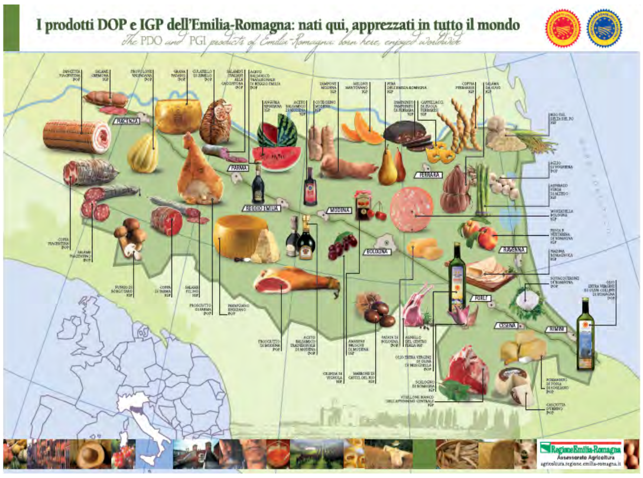

Figure 4 (Source Emilia Romagna region)

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Using Precision Urban Agriculture to Bring Food to the Plate of Low-Income Populations

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1. Summary

Precision urban agriculture (PUA) uses new technology to grow food in cities in a fraction of the space of conventional farming, using a fraction of the water and eliminating problems such as run off. Growing within the urban environment allows an engaged loop between production and consumption which exemplifies a smart grid for food approach. This case study focuses on a mid-sized city within the United States—Oakland, California and looks at the impact and infrastructure needed. There are three components to the proposed system:

- Precision growing systems able to grow a select range of crops using less than 3% of the water, 1% of the land and 20% of the nutrients of conventional agriculture.
- Localized processing and distribution systems that leverage geographic proximity and short harvest delivery times to bring down costs within PUA.
- Integration to the urban policy making to create a "path to the plate" to ensure produce reaches low income urban populations.

2. Introduction

Agricultural production systems contribute to a range of problems, including depletion of non-renewable groundwater, soil erosion, deforestation, greenhouse gas emissions, environmental toxicity from the use of chemical pesticides and herbicides, and dead zones in waterways due to fertilizer runoff. Paradoxically, despite the tremendous productivity and environmental cost of agricultural production many urban citizens in the United States live in "food deserts"—localities where little healthy food is available and where, in contrast, residents are surrounded by outlets carrying unhealthy fast food. This case study explores precision urban agriculture as a contributive solution to both these social problems.

Precision agriculture uses soilless growing and tailors the growing environment to the precise needs of each crop across a range of variables: light, temperature, nutrients, humidity, pH, airflow and carbon dioxide. Fully enclosed, these systems grow plants using 1-8% of the water used in conventional farming, 10-40% of the fertilizer, a fraction of the space and with no pesticides. Precision agriculture can grow plants up to 50% faster, minimize crop loss and variability in production, increase growing cycles per year and grow plants with enhanced nutrient profiles. Despite these benefits, challenges restrict the use of these systems:

- They grow a limited range of vegetables, primarily leafy greens.
- While efficient in their use of water and fertilizer they use significant amounts of electricity, building materials and other resources.
- They are capital intensive to build and costly to run.
- They require a sophisticated understanding of plant science, engineering, and technology to develop, monitor and maintain.

To ensure PUA systems go beyond producing expensive micro-greens, herbs or specialty lettuces for high end consumers several things need to happen:

- Continued technological developments to enhance the efficiency of PUA systems
- A smart grid approach to reap the benefits of the co-location of agricultural production and a large consumer base.
- A more intentional structure for working with institutional partners and the policy infrastructure already engaged in feeding low income populations.

3. Case Study

a) Resource efficiency and sustainability

A single head of lettuce takes 23 gallons of water to grow. California produces 90% of the United State's leaf lettuce and 83% of its romaine lettuces consuming more than 81 billion gallons of water to produce lettuce alone. These billions of gallons represent not only a drain on the state's precious water supply, but also become the vehicle in which agricultural activities carry excess fertilizer, pesticides and herbicides into water ways. Lettuce is a good indicator crop as it can currently be grown reliably within controlled environment agricultural systems—though at a cost premium we estimate to be at about 25% to 50% above the cost of growing in traditional systems. Using conservative estimates, growing lettuce for Oakland using a precision agricultural system would save of 136.44 million gallons of water and over 12 tons of fertilizer each year. Moreover, it would provide food which was pesticide free, fresher and likely with a higher nutrient content.

b) Underlying socio-economic realities

Despite California's bountiful supplies of nutritious fruits and vegetables, its inner-city communities are chronically deprived of those very foods. Cities like Oakland are riddled with food deserts—localities in which little healthy food is available, and community members are more likely to get their calories from unhealthy fast foods than from nutritious vegetables, fruits and grains. Overall 1 million Californians, most of them city dwellers, live in food deserts. Food deserts impact over 13 million individuals in the United States and are a part of a larger national crisis in nutritional health. Fewer than 14% of American adults and 9.5% of adolescents eat the recommended number of servings of fruits and vegetables; and low-income families eat 18% less vegetables and 8% more added sugars than the rest of the country. This contributes to alarming levels of obesity, diabetes and a host of other illnesses among low-income American families, particularly those of color, and those in inner cities. Nationally, obesity and diabetes contribute to over 20% of health care costs. For PUA systems to be able to impact these issues they will need to bring produce to market at a price comparable to what consumers are already paying and integrate their production into the systems that are already putting food on the plate of low income populations.

c) An approach to processing and distribution which will support economic viability

So if PUA produce costs more how can we get it to low income consumers for less?

- **Responsiveness to demand fluctuations:** Unlike traditional agricultural systems PUA is season independent and protected from crop loss due to weather, drought or other external variables. Additionally, PUA systems have relatively precise windows for crop maturation and regularity in the size and volume of crops. We see several opportunities for supporting the economic viability of PUA systems that align with the underlying smart grids approach. First data on seasonal variation in crop prices can help PUA systems to target what crops to prioritize at different times. Second, PUA systems can develop contracts with institutional buyers based on average seasonal cost. Thus, even though they cannot be cost competitive during peak production times for conventional farming they can bring goods to market based on a competitive average price and the ability to provide a consistent crop over time.
- **Reductions in cost in the supply chain:** Within existing farm systems the costs of growing food is a small percentage of the final retail or wholesale price. The farm price for lettuce, for example, has hovered between 20% to 30% of the retail price for the past 20 years. Just in time production and the short distance from farm to consumer should allow for dramatic reductions in costs such as refrigeration, storage and transportation. Secondary reductions in packaging may also be possible. Much current packaging is designed with the need for transportation, storage and the need to protect crop through multiple transitions. Additionally, there are some fundamental differences in PUA crops. Conventional lettuce, for example requires triple washing to remove soil and soil-based contaminants. PUA crops are harvested relatively clean making this less necessary.
- **Reduced waste:** For a vulnerable crop, like lettuce for example, it is estimated that about 50% of the crop is lost from farm to table. These losses are based on many things: unevenness in growth resulting in produce that is not desirable to the consumer or doesn't fit existing packaging, natural deterioration over time, handling during processing and, of course, mismatch between supply and demand. PUA systems have advantages over conventional systems in each of these areas: growth is relatively uniform and predictable, proximity to consumer means produce can be delivered quickly and processing can be short-cut

d) Bringing together food-production and food-consumption in place

Our goal is not only to impact the environmental footprint of farming, but also to impact health outcomes in urban centers—focusing on families with children and to make a positive contribution to the urban economy. This case study focuses on the City of Oakland, California and seeks to map important assets within the urban environment for a smart grid for PUA. These include:

- **Food Policy Council:** Food policy councils bring together diverse stakeholders across public and private sectors to look systemically at food policies within a locality. Oakland's food policy council's mission is to establish an equitable and sustainable food system for the city of Oakland. Oakland is one of over 200 communities in the US with a food policy council.
- **A School System Invested in Healthy Foods:** District-wide Oakland schools serve a population that is 80% high need. Low income children consume almost 50% of their calories at school. The Oakland Public School System is already deeply invested in healthy foods. They are opening a central farm, kitchen for food processing and educational center in 2017. They operate a series of farmer's markets on school sites which take EBT (US food subsidy funds for low income families). They also run a farm to school program designed to bring fresh food directly into the school system. The system serves about 37,000 students per year.
- **Institutional Buyers with Aligned Values:** Oakland (along with other Bay Area communities) is also showing national leadership around healthy food purchasing. These are agreements among institutional buyers such as hospitals and universities to ensure purchasing agreements prioritize food that is healthy, sustainably and ethically produced and contribute to local economies.
- **Healthy retail outlets within low income neighborhoods:** An existing healthy retail outlet initiative in Oakland is working with corner stores in low income neighborhood to help them build the infrastructure and market to increase their produce sales. These outlets are an important part of the food grid. They are where many low income consumers shop and they often carry little to no fresh produce. There has been significant national work to better understand the barriers to these outlets ability to carry fresh food and we believe that the daily small batch deliveries of PUA produce can help to address these constraints.
- **High End Market:** A financially sustainable model will need to integrate the type of high margin products (specialty lettuces, micro-greens, etc.) that are currently the focus of other precision agriculture efforts. Oakland, and the Bay Area in general, has a wealth of high end restaurants and grocery stores which serve high end customers and are mission aligned with this larger effort.
- **Reaching Families with Young Children:** During early childhood the brain is developing more rapidly and eating patterns are being set that will influence lifelong behavior. Alameda County, where Oakland is based, has a robust early childhood network led by a funder (First 5) which also coordinates and networks the early childhood community. Our goal would be to engage with this community and integrate produce distribution through key early childhood partners including:
    - **Home visiting programs:** Home visiting programs send parenting coaches directly into the homes of low-income families that are expecting or have very young children. New federal investments have been expanding home visiting throughout the US.
    - **Child care and early education:** Low-income children get half to 2/3 of their calories within child care settings. New federal guidelines released last year encourage these settings to integrate more fresh produce into menus.
- **A Food Justice Movement:** Oakland has an active food justice community which includes community-based organizations which are already in deep engaged relationship with the very communities which this effort seeks to target. These will be crucial partners for the work.

e) Analyze future developments (3-10 years)

These future developments will effect this work:

- It is likely that climate change will continue to impact California's agricultural productivity. This will impact crops not only statewide but nationally and increase the urgency of finding low water agricultural solutions.
- Continued developments in LED efficiency and solar energy generation will continue to bring down the capital and running costs of PUA systems.

- Because of the high cost of setting up systems and the current barriers to profitability there is a lot of competition and little collaboration within the PUA field. Plant formulas and underlying system technologies are closely guarded and not shared. This prevents the whole field from growing and developing. Over the next ten years as solutions in lighting and other arenas come on line and more publically funded institutions like Universities and National Laboratories expand work in the space there will be a shared collaborative space for innovation which can infuse the whole field.

f) Proposed actions to address the criticalities and/or strengthen potential (today – 10 years)

Develop plant optimization formulas for a varied basket of crops. While lettuce has served as a useful signal crop within this case study, in the end the narrow range of crops produced by PUA systems is one of their weaknesses. What is needed is optimization formulas specifically for a basket of crops that meet three key criteria:

- A dense profile of bio-available nutrients based on the Center for Disease Control's definition of powerhouse fruits and vegetables.
- Suitability to efficient growth within a controlled environment.
- Consistent with food culture of the populations we are trying to reach.

Bring down capital and running costs for PUA systems. The large investment needed to start a PUA farm and the on-going costs—especially in electricity continue to impact viability for PUA farms. Continued research in many areas is still needed including: lighting, airflow, pest and disease control, better understanding of micro-nutrient needs, strategies to address (and potentially utilize) waste heat and automation of specific aspects of PUA systems.

Develop localized distribution strategy. Much of current agricultural distribution relies on large wholesalers who aggregate food from multiple farms and distribute to large stores. Part of the approach outlined here depends on getting food directly to low income consumers or to hubs such as child care programs, home visitors, or corner stores. The infrastructure of existing distribution systems from truck size to standard packaging) is not structured to nimbly be able to distribute small batches of produce to distribution nodes. To do so effectively and cost efficiently the distribution infrastructure may need to be rethought with options including

Leverage existing food policy programs serving low income populations. There are a range of food programs in the US designed to serve low income populations. Forty-three million Americans, or over 14% of the US population receives food aid through the Supplemental Nutrition Assistance Program (SNAP). Another 46 Million Americans use food banks. Eight million pregnant women or families with infants get nutritional support through the Women Infant and Children Program. Over 4.3 million children and adults receive meals subsidized by the Child Care and Adult Food Programs. A complete analysis of the existing food subsidy programs their structure and eligibility will support a strategy to get produce from precision farms integrated into the distribution systems of these existing subsidy programs.

Integrate a more complete food cycle approach. We are currently having a series of highly exploratory conversations with partners about ways to integrate PUA strategies into a larger eco-systems approach.
Examples of these conversations include:

- How can waste vegetation (root mass, non-edible plant matter, etc.) and bio-streams from the urban landscape be converted to fuel to support the energy needs of PUA farms?
- Can purified urban waste water be used within PUA systems?
- Can we integrate a model for value added food development to PUA produce (e.g. not only growing basil but producing pesto)?
- How can we integrate PUA into block scale efforts to enhance energy and water efficiency in urban landscapes?

8. Conclusion

A 30-year vision would be for precision urban agriculture to be an integrated part of the larger agricultural production system. Certain crops—like lettuce and leafy greens would be produced primarily within these controlled systems at the local level and distributed in a just in time basis to local consumers. Overall this would reduce the overall agricultural foot print and enhance health outcomes for low income populations within cities.

Boston: a hub/spoke model of urban agriculture

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1. Summary

This case study describes the urban food system in the geographic area of Boston, Massachusetts, USA. It mainly focuses on the distribution and transportation of food from farm to table, but broadly describes the situation for urban agriculture.

2. Introduction

This case study broadly focuses on the food system that supports the City of Boston, Massachusetts. There is an active ecosystem in the city proper, however Boston is also a hub for regional agricultural producers, and value-add product developers, including distribution and sales through a diversity of markets and delivery systems. The economic viability of small farms is a challenge even in rural areas in the Northeast United States, however, farming in the city adds new layers of complexity. There are a few commercial models, but several active players are not-for–profit or subsidized social enterprises focused on community building mission. Addressing these challenges will involve increasing efficiency as well as “redefining” economics. Markets, sources of energy, water, and labor inputs, access to critical resources such as land all factor into the urban agriculture equation. New sources of “community capital” have emerged. For example, UFI is tapping the “intellectual capital” of the New Entry Farming Project some 35 km away to build its farming training program, and build resources such as mobile poultry processing.

The local ecosystem includes transport of regional produce, fish, meats and dairy, as well as an array of processed products from the region. Boston proper has few actual farms, save those developed as part of community supported organizations.

3. Case Study

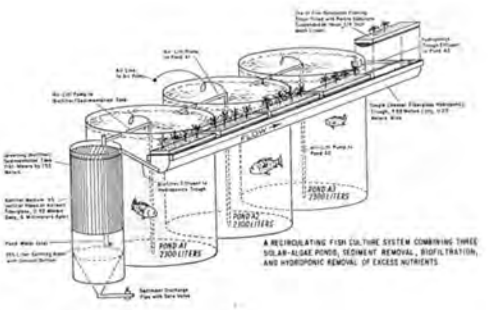
There are few commercial farmers in the City of Boston. The high cost of land, utilities, and labor puts commercial operations at a disadvantage to the less dense suburban and rural operations within a few hours drive. One company, City Growers, operated both a for-profit and a not-for profit, to discount the cost of land, and was creative in making arrangements with community organizations to gain access to labor. They are now focused on the social ventures described above in section 2, the Urban Farming Institute, and some innovative models, for example Corner Stalk, a hydroponic farming enterprise growing produce indoors with grow lights in retired shipping containers parked in parking lots. Land-based farms include relatively small plots leased at low cost to non-profits, and rooftop enterprises seeking to capture waste heat and free real estate. Some fruit orchards remain in the city but are similarly community oriented. There is a network of over 200 Community Gardens covering 50 acres. However, these efforts are not only subsidized by philanthropy, they are providing nutrition to a very small portion of city residents. Most of the produce sold at farmers markets was grown elsewhere in the region. The Commonwealth of Massachusetts has more than 7700 working farms, but Boston as a hub draws produce, meat, dairy, fish and shellfish from the spokes of the other five New England States, and beyond into New York and Canada.

Aquaculture is significant in Massachusetts (MA) and New England. According to a market study, in 2011, MA issued 378 shellfish licenses for 420 hectares. With no commercial finfish sites in the marine environment in MA, shellfish farming is the dominant form of aquaculture including oysters, hard-shell and soft-shell clams, bay scallops and blue mussels. There is at least one land-based shrimp farmer in operation. Australis Aquaculture is a five acre farm located in Turners Falls, MA (also in Van Phong Bay, Vietnam) utilizes sustainable aquaculture technology, such as innovative water reuse systems and feeds to grow Barramundi. As one of the world’s largest indoor fish farms, Australis is adamant about the high quality of both feed and fish, and works closely with environmental groups to ensure consistency. The company supports its fishermen by paying better prices and advancing them feed and equipment, enabling them to better themselves and their communities.

This land-based closed aquaculture system could be a model for urban aquaculture facilities, although smaller-scale operations based on the designs developed at the New Alchemy Institute in Falmouth, Massachusetts during the 1970s and 1980s may be more applicable.

Another model is the CDC Farm and Fishery, an indoor self-sustaining ecosystem that will provide fresh fish and vegetables to both individuals and restaurants in Detroit, Michigan in a neighborhood severely lacking in fresh food products. There, tilapia are raised in a large aquarium, and the water from the fish tank is pumped to a worm bed where the fish waste is broken down into nutrients for the plants. The water then moves through a series of plant beds, naturally fertilizing them. Once the nutrients are absorbed, the clean water then returns to the fish tank and the cycle begins again. This is biomimicry applied to urban environments.

Aeroponics.



Boston proper has few actual farms, save those developed as part of community supported organizations. There are several, including:

Urban Farming Institute (UFI), seeking to develop and promote urban farming as a viable commercial sector that creates "green jobs" for residents and engage urban communities in building a more locally based food system. Addressing economic viability challenges will involve increasing efficiency, as well as "redefining" economics. UFI plans to convert a former 19th century farm one of Boston's poorest neighborhoods into its headquarters where it will host a training program in partnership with New Entry Sustainable Farming Project and the Trust for Public Land. The Food Project grows on two plots of land in the city's Dudley neighborhood. Food harvested from these farm sites supports a Farmers Market and several local hunger relief organizations. In 2010, two non-profits collaborated to operate a 0.1 Ha Dudley Greenhouse in Roxbury. Half of the greenhouse is designated for enterprise, where produce is grown for local restaurants. The profits provide much of the revenue that supports the other half of the greenhouse, called the Community Bay where plots are made available to local residents.

ReVision Urban Farm grows produce in its own fields and provides access to affordable, nutritious and culturally appropriate food to residents of our ReVision Family Home and the extended community and provides job training for youth and Boston's homeless, and operates a CSA program.

Commercial enterprises in Boston include:

Green City Growers was established to install and maintain organic urban farms in unconventional spaces, providing custom technologies for season extension, and a rooftop farming system, that has grown over 80,000 kg of organic produce, valued at over $600,000, donated 5500 kg of produce, & worked with more than 7,500 people on urban farms & gardens which cover less than 0.8 ha, including the roof of the Red Sox baseball park.

Freight Farms have the potential (already being realized) to expand our thinking about the land resources available to urban farming/farmers. These innovations do not require arable land. They can be set up almost anywhere in the city – the major requirement being a source of electricity. They do, however require a substantial capital investment. The Leafy Green Machine is a pre-assembled hydroponic farm inside an up-cycled freight containers capable of producing yields at commercial-scale in any climate and any season and costs about $85,000. Subsidies and creative financing may help level the playing field here.

Another innovation that expands the growing areas in crowded cities is rooftop farming. Taking advantage of unused open space in ways that benefit the building owner (reducing energy costs via vegetative cooling), Higher Ground has 0.5 ha of growing space making it one of the largest rooftop farms in the world. Since it is open air it is subject to Boston's relatively short growing season. Supported by a network of public and private organizations, their produce is sold to local markets and restaurants. A next iteration on this concept would be the construction of rooftop greenhouses, such as those that have been constructed in Brooklyn, New York, Chicago are in the vanguard. Ironically, solar panels may be the biggest potential competitor for rooftop acreage. Vertical farms represent a further step in design evolution, but have yet to be created in Boston.

a) Socio-economic realities

Distributors. Locally and regionally produced agricultural items are transported to markets, restaurants and high end retailers in Boston, generally by roads, and fish via waterways. There are several notable aggregators that make distribution more efficient and affordable.

Reds Best Seafood works with over 1000 small commercial Cape Cod fishermen to bring their fish to markets in Boston and beyond, including wholesale (Fish Pier), retail outlets (Boston Public Market), farmers markets and CSAs. They maintain tracking software to certify the type and source of fish, and deliver it daily.

Food retailers. The city of Boston currently operates 27 Farmers Markets. Most are seasonal, but a few operate year round, and sell farm produce, seafood, meat and dairy products, as well as value add products. A public private partnership developed the Boston Public Market as a destination showcasing regional agriculture and food production, with 37 vendors selling regional produce, animal products and prepared food vendors. Red's Best and the East Boston Freight Farm, already described, are vendors. Whole Foods is a national natural foods grocer with a program to sell locally grown and prepared products that meet quality standards. Several local grocers also sell local products. Some publicly and privately funded efforts provide coupons to low income residents to purchase produce at these markets, however most of these resources serve wealthy city dwellers who are willing and able to pay for fresh and local food.

Consumers. Boston has a Green Restaurant Certification Association. REAL25 restaurants are selected through a comprehensive algorithm that considers how food is made, where it comes from and which health-focused diets it accommodates (amongst other things). The selections are verified by a local Expert Advisory Board. Some of these restaurants already source locally as much as possible. Those that do not at the moment are among the most promising future candidates.

Consortia and organizations. TTOR provides resources and training for community gardens. The City of Boston Office of Food Initiatives maintains a map of Farmers Markets, and offers a program called Bounty Bucks that allows people receiving food assistance recipients to get subsidized produce in Farmers Markets. The Boston Bounty Bucks program is funded through the Food Insecurity Nutrition Incentive grant from the USDA and the BostonCANshare campaign. The Boston Public Health Commission and Boston Collaborative for Food and Fitness help administer the program.

Organics in waste. Since 2014, Massachusetts has had a ban on commercial organic waste going to landfills. Driven by a lack of space, the policy is driving innovation, including composting, anaerobic digestion, and new collection and distribution systems. Boston's urban farmers start from the premise that the soil is contaminated. Consequently attention is focused on raised beds and building "virgin soils" on top of and physically separated from the urban topsoil. Composting provides nutrients and clean soil. Anaerobic digestion and composting are the viable options for handling organic waste. Exurban and rural farms on the urban fringe are attracted to the tipping fees for composting food wastes. Their need to move finished compost to make way for more waste (and additional tipping fees) may create opportunities for urban farms to acquire high quality, affordable compost in quantity. A smart grid facilitated distribution network could be a key to success.

b) Education

The Urban Farmer Training Program (UFTP) trains residents from Boston neighborhoods in the specifics of small plot urban farming. Individuals explore various aspects of urban farming such as food systems, soil quality, environmental challenges and opportunities, crop planning, organic agriculture, and farm-business planning.

c) Policies and regulations

Article 89, the zoning ordinance that allows for commercial farming in the city of Boston provides a legal context for accessing land for urban agriculture. The city has joined forces with the Harvard Food Law and Policy Clinic to develop a guide to permits and approvals needed to start a less-than-one-acre ground-level farm in Boston.

e) Food Processing

Commonwealth Kitchen, funded by a variety of public and private organizations, is a mission-driven not-for-profit that provides shared kitchens and business assistance to entrepreneurs building food businesses, allowing them to meet Food Safety and handling regulations, and use shared equipment. A barrier for local meat processing is the lack of a USDA inspected processing facility. A non-profit has created a mobile processing facility for chickens, traveling statewide.

f) Future developments (3-10 years)

Available land. One recent study estimated that if Boston cultivated produce on 20 of the more than 2500 hectares of open space, it would produce roughly 700 tons of food, or 6 million servings. Still, this would only be 10 meals per person per year.

Dietary shifts (income growth, demographic change). Boston is very expensive place to live. Wealthy residents may invest in fresh sustainable local food. Known for high quality seafood, local resources may also experience growth.

Climate change should be a driver for greater investment because major storms can impact transportation of food from further sources. Changing weather conditions may also affect the productivity of these perennial sources. Temperature increases might extend natural growing seasons. More controlled solutions might also be a response. The seafood industry is at high risk as changing currents and water temperatures affect the size and location of fisheries. For example, the cod fishery is almost exclusively outside of US waters, and it used to be the lifeblood. Increased ocean acidification may have other effects, for example on shellfish, by changing water chemistry and system dynamics.

Water and energy scarcity will make food more expensive, but will drive more efficient technology development. Alternative energy and water reuse technologies might grow more quickly.

Improved pest management technologies will reduce the need for soil and plant treatments, and improve yield.

e) Proposed actions to address the criticalities and/or strengthen potential (today – 10 years)

Natural Resources. As mentioned, land is very expensive in Boston and it's co-located suburban communities. There is little available space, and great demand for it. Freight Farms outfitted trailers cost around $70,000 USD, and still require water and electricity hookups. While water reuse might eventually lower the cost, currently, purchase of market rate drinking water is costly, and high energy costs must be addressed. Further, weather adds cost and inefficiency, as there is a very short growing season. Indoor solutions still demand energy, and at greater intensity in the colder seasons. Because they are climate-controlled environments, freight farms, urban greenhouses and vertical farms may be one of the most important hedges against the uncertainty of climate change. Today they produce food primarily for high-end markets because of market demands. However, in the future they may be growing basics that meet citizens' everyday food needs.

Food Production **Agriculture**. Cost and inefficiency remain significant barriers to further production. Presently, urban agriculture is subsidized. There is a need to increase efficiency, and diversity of the crops produced. **Animals.** Creative solutions to urban animal farming are needed, or alternatively, models that improve delivery of animal products to the city. **Aquaculture**. In the future, fish will more than likely be farm-raised. The resiliency of the fisheries community requires better problem formulation (why are stocks depleted; how can policy support growth of a diverse coastal ecosystem and derive economic and community benefits from it); and land-based farming solutions.

Food Processing. Current model is an incubator social venture, [CommonWealth Kitchen]. Again, not a commercially viable enterprise, more analysis is needed. Scale is likely an issue for economic viability. Like-minded aggregation could help.

Food Distribution. Smaller farms challenge efficiency. Aggregation, such as Farmers to You brings farm produce, animals, fish, and prepared foods from Vermont to Boston customers. A local model has to challenge large competitors, like Amazon Fresh. The use of cellulose nanomaterials in edible food coatings to protect produce/meats from water & oxygen can improve storage.

Food Consumption. Lack of familiarity with crops – people don't know how to cook the foods. People don't cook as much. Solutions need to encourage cooking. An innovative nanotechnology called engineered water nanostructures is a water based disinfection technology invented by Professor Phil Demokritou at the Harvard School of Public Health that requires water and electricity, but does not use chemicals or radiation to disinfect food surfaces.

Waste Management. New technologies for closed loop organics yard waste and post-consumer waste composting. Urban commercial farming will require infrastructure for composting. Article 89 criteria – central vs. distributed compost suggest need for a model. Technology to capture nutrients, gas, heat and address traffic and odors are critical to success. Firefighters have expressed safety and biogas concerns about rooftop composting.

8. Conclusion

Although technologies have improved, more refined information about ambient conditions can improve growing conditions and natural threats to urban farming. More importantly, technologies that improve the efficient use of resources are needed to reduce cost, and to match supply and demand. As climate continues to bring disruption, technologies that allow distributed generation of safe and high nutritional quality food production will reduce food insecurity and hunger.

There has been extensive work throughout Africa by researchers and small farmers to develop drought resistant crops. New strains of resilient vegetables and fruits could be very important with respect mitigating the impacts of climate change here in the U.S. A nascent network linking small farmers in Africa, the Caribbean and the U.S. is taking shape coordinated by the Historically Black Colleges and University (HBCU) system. There is a sense of urgency that a mechanism for sharing this information be established to ensure that it remains within the control of small sustainable farmers. A well-designed smartgrid could be of great benefit.

Impact of social and climate changes on rice production in Middle Casamance, Senegal

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1. Summary

Casamance is one of the poorest regions of Senegal despite being rich in natural resources. Casamance has long been isolated and affected by a civil war.
Food production is not sufficient to meet local demand, largely covered by rice imported from Southeast Asia. The system is particularly vulnerable to external shocks linked to markets. The traditional rice-growing system in lowlands is managed by women, while in plateaus other crops (millet, maize, groundnut) are cultivated by men. The plateaus' soils show signs of deterioration and crops are increasingly exposed to climatic variability because of climate change. Despite the valley agriculture is more resilient to climate change and the existence of untapped areas, it remains underdeveloped and subsistence oriented. Many efforts have been made to resolve environmental and technical limitations, without adequate consideration of the social and economic aspects. Currently, the challenge is to make rice-growing a modern activity and not only a subsistence one, to ensure food security as well as economic development.

2. Introduction

The Middle Casamance, corresponding to the current Sédhiou Region in Senegal, has important freshwater (Casamance River) and forest resources and favorable soil and climatic conditions. Climate change and variability are modifying the landscape and exacerbating natural resources degradation processes induced by anthropogenic causes (Tarchiani et al 2015, Fiorillo et al. 2016). Population growth (2.6%), internal displacement due to the Casamance conflict, and migration from other Senegalese regions, have strong impacts on the ecosystems and the land use of the territory. Sédhiou region is still a rural area with only 15% of urbanization (ANSD, 2014). Because of its geographical position and poor infrastructures, the region is isolated from the rest of the country. The Casamance River cuts the region in two parts without any bridge or ferry service within the regional borders.

The Middle Casamance's agro-systems follow the topography and can be characterized on the basis of land resource: plateaus, lowlands and house gardens. Agricultural production systems are characterized by a long rice growing tradition, especially in the lowland areas.

Other crops cultivated on the plateaus are millet, sorghum, maize and fonio, as staple crops; peanut, cashew and other cash crops. However, agriculture is still characterized by low productivity and low inputs. The competition between staple and cash-crop results in the fact that most resources are invested into cash-crops, even if they are more exposed to climatic and market shocks.

Staple crops production doesn't cover local food needs. The main staple food is rice, and it is bought on the market for much of the year, given that local production is limited. Low yields of rice do not allow farmers to have surplus production to sell and make local rice prices uncompetitive with imported one. All this entails a low economic value of rice despite its social traditional value. Therefore, young generations escape and, in the long run, a process of workforce and interest depletion is observed.

3. Case Study

The Sédhiou Region covers an area of 7,340 km2, of which about 30% is occupied by cropland with a strong predominance of dry herbaceous crops. Rice is cultivated in lowland (17,850 ha) and river side (6,660 ha) areas, covering 2.5% of the Region (Manzelli et al 2015a).

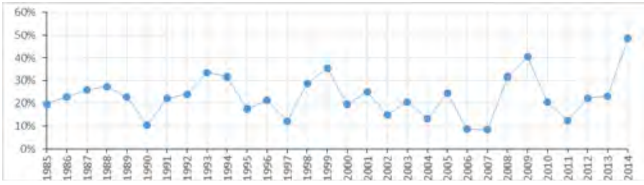
Soils of lowlands are generally clay or sandy-clay hydromorphic soils, with good aptitude for rice. River side soils present unfavorable conditions for rice cropping, being often halomorphes and acid because of sulphide oxidation (mangrove soils). Moreover, some soils subjected to water stagnation are affected by toxicity of metallic elements (Fe, Al, Mn).

The lowland rice production system is based on two species *Oryza sativa* and *Oryza glaberrima*. Moreover, a group of interspecific cultivars called New Rice for Africa (NERICA) have been produced by cross-breeding of the two species.
At least thirty different improved varieties are used in Casamance for lowland rice production, of which some adapted to halomorphe or acid soils. Nevertheless, they represent less than 10% of used seeds, the rest being local ecotypes, maintained over the years by farmers.
The Institut Sénégalais de Recherche Agronomique (ISRA) and Africa Rice ensures rice seed banking in Senegal and the production of certified pre-basic seed (G0 to G3). Basic seed production (G4), R1 and R2 is provided by the farmer's member of local seed organizations. The whole production process is controlled and certified by the Ministry of Agriculture.
Rice growing in the area is considered as rainfed, indeed irrigation is done by managing meteoric water. The climatic pattern in Middle Casamance is unimodal from June to November with an average annual rainfall amount of 1180 mm.
The density of the river system makes this area very suitable for rice cultivation, especially in lowlands. The main rivers are the Casamance and the Soungrungrou, a tributary of the right bank of the Casamance. The Casamance River is largely affected by the intrusion of marine waters, which has led to a gradual increase in salinity and acidification of the soils, especially in the mudflats and in some lowlands.
Anti-salt barriers have been built since the sixties in several valleys along the Casamance River and its tributaries. These are often associated with upstream retention dams allowing the management of water in the different sections of the valley. Fields are generally closed by small bunds to retain rainwater. Mismanagement of anti-salt and retention dams often causes uncontrolled submersion or drying of the rice fields. Moreover, recent changes in rainfall pattern expose rice to unusual dry-spells during the cropping season.
The use of agricultural inputs is generally low (around 50% of farmers). Main fertilizers are NPK, urea and organic manure. Among farmers using fertilizer, the average quantities used per hectare are generally less than the recommended doses.
Since rice is mainly grown for auto consumption, the system is unable to finance itself and the purchase of inputs for rice depends on the family income. Moreover, the competition with other activities is usually detrimental for investments in rice.
Generally, a higher use of inputs is observed among seeds multipliers, which have a better access and often use those inputs also for food rice. The use of phytosanitary products is practically non-existent and mechanization is very sparsely used. Generally, all cropping practices are manual.
Agricultural inputs are purchased from state-owned stores localized in each rural district at subsidized price (Manzelli et al 2015b). Some households buy inputs by credit through NGOs and projects. Nevertheless, the access to credit and to selling points, considering the poor road and transportation network mainly during the rainy season, are the main obstacles in the use of inputs. WFP estimated that 96% of households have supply difficulties at the peak of the weld in August.

Valley rice farming is an activity exclusively carried out by women. The workforce is typically found inside the family with a contribution of wage labor depending on the areas. The exchange of work is also used for the more intense works (soil preparation, transplanting). Farmers are often formally organized in Peasant Organizations, whose main role is to allow the access to funds or subventions.
Land ownership and land management is a sensitive issue, as is the case in most West Africa countries. There is no land property, so the land is held by the state that gives it in concession. The household has the right of use and transfer from generation to generation (inheritance). The wife obtains the right to use the land only through marriage and, in case of polygamy, the first wife decides the allocation of the plots to the other wives. The loan is the second method of land acquisition for rice farmers in the form of sharecropping, knowing that after the harvest, part of the rice must be given back to plot owner.
The education level of farmers is generally very low, often the most women are illiterate. PAPSEN Programme is providing training and technical assistance to farmers of 24 valleys with around 1200 direct beneficiaries. Training activities concern cropping practices, farmers' organization, use of improved varieties and post-harvest techniques. The technical assistance programme of PAPSEN include the presence of an agricultural counselor for each valley. The training and technical assistance programme since 2014 showed net impact on crop yield (Manzelli, 2016).

Rice produced in the valleys is locally consumed (75% of production) and generally is not present even in local markets (only around 1% is marketed). Around 7% of production is conserved as seeds, while only 2% is lost. Processing of rice for food is done manually, with relevant transformation losses (45%).
For a long time, the rice cropping system has not been able to satisfy the food needs of households who are obliged to fill the rice deficit by purchasing imported rice (broken rice from southeastern Asia) on the market. The evolution of the coverage rate of total cereal requirements by rice from 1985 to 2014 (Figure 2) shows that rice contribution varies greatly over the years. On average, it provides less than 30% of the year's coverage of cereal needs. The peak contribution was reached in 2014, when rice covered almost 50% of the cereal needs of households in the Sédhiou region.

Evolution of cereal needs coverage rate by rice in the Sédhiou Region (Source : Ngom et al. 2016a)



Therefore, households' food security largely depends non-agricultural activities, money transfer and cash crops (Ngom et al 2016b), being vulnerable to respectively climatic and market shocks (prices of imported rice, prices of cash crops). In fact, rice cultivation is taken from a double constraint. First, it is subjected to technical constraints (low inputs because of low value) and second, it is subjected to competition from activities that are more remunerative.
More accessible areas show an economic context more conducive to the development of commercial rice growing given the better integration of the valley into the markets (inputs, labor, agricultural products) but in this context rice growing suffers the competition by non-agricultural activities (young women migration toward towns or more profitable activities).
Landlocked areas suffer from low market integration, limited access to inputs and credit, but agriculture is still the primary activity for meeting food and monetary needs.
In this context, supporting valley rice farming can play a role increasing the resilience of farmers to market and climate shocks. Indeed, rice cultivation in lowlands is less sensitive to climatic shocks than cash crops, and still has relevant margins of improvement.
In addition, non-agricultural activities are mainly accessible to men rather than to women. Thus, households with a large female presence are at risk of being once again vulnerable and food insecure. Consequently, valley rice growing with its gender connotation can also become a potential activity for women who are excluded from most income-generating activities.

The population of the Sédhiou region doubled over the period from 1976 to 2013 with an annual growth rate between 2002 and 2013 of 2.6%. Food expenditures dominate the household portfolio (WFP, 2010). Considering that per capita rice consumption in Senegal is the highest in West Africa, rice demand will dramatically rise. This demand is not satisfied by the offer, although the latter increased over the years. Indeed, during the same period, rice production in the region grew with an annual rate of 7.85% (on average on plateaus and valleys) also thanks to yield increases (21% in 10 years). All this justifies further intervention on rice cultivation.

According to the studies carried out by Bacci et al., climate change is expected to have minor impacts on rice production in Casamance. Impacts on water resources could be even positive in terms of Casamance river discharge in the next 20 years (Bodian et al. 2015). The only feature that can affect rice production is the intensification of rainy events with a consequent potential increase of dry spells, mainly during crop critical phenological phases (Bacci, 2015).
Today, the labor force in rice growing is decreasing because of low generational renewal (Manzelli et al. 2015b). Younger generations are attracted by the offer of employment in non-agricultural activities, especially in urban areas, or more profitable productions. Indeed, the more valleys are integrated into the markets, the more households prefer to abandon productions dedicated to self-consumption, in favor of productions or activities that provide a monetary income.

The development of valleys is the center of the problem. They are a valuable resource, that is underexploited and managed by women within a traditional strategy of food security and risk distribution. The proposed approach is to design and implement an integrated strategy to make women engines of development, defending their role, but enabling them to use technologies and manage water resources and marketing:

Support work organization within farmers' organizations and households: the major driver of system development.

Facilitate the access to land to women: overcome the lack of manpower.

Facilitate investments and credit coupling food production with seeds production: ensure improved access to credit and inputs.

Development of an improved seeds system and market involving local farmers in seeds multiplication: a flywheel for local development.

Support community based management of anti-salt dikes (primary management) and diffuse technics for secondary management of water (in the fields).

Dissemination and demonstration of new cropping practices through farmer field schools: improve productivity to rise the offer on the market, increase women revenue and then more investment in agriculture.

Support farmers in the diversification of crops in lowlands during the dry season.

Develop market and trade of local rice: valorize the demand of rice on the market, increase the competition with imported Asian rice, which price is subsidized profiting urban communities but disadvantaging local producers of rice.

8. Conclusion

The local rice in Middle Casamance is a unique food system, with high social and traditional value but exposed to multiple stresses. The challenge is to conjugate proper technical, social and economic solutions. Production intensification is still lagging, despite technical improvements are showing substantial yield increases. Moreover, technical assistance effort is currently supporting around 1200 women, but how is it possible to scale it up to 20.000, while developing a sustainable mechanism? The long-term objective is the economic security of the population by a radical evolution of the production system toward a market oriented sustainable model. Farmers' organization seems to be the only possible option for the uptake of technical improvements and the intensification of rice production. The main effort should be the promotion of farmers' organization transforming groups of women into effective actors able to manage and develop natural resources, intensify productions, improve the access to inputs and the output to markets of local rice. The objective is to overcome the food security strategy toward household economic security. Valorization of local rice on the market will attract young generations, that in turn will allow the system to further develop. The potential of rice production in Casamance exceeds regional's demand. Moreover, offering local rice to national markets could push the Government to revise importation and subvention policies.

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Expanding Maize Utilization as Food through Mexican Processing to enhance Nutrition, Health and Development in Kenya

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1. Summary

Maize is the most important staple crop in sub-Saharan Africa (per capita consumption of 103 kg/year; source of 31% of calories and 28% of protein intake). Nixtamalization, a technique traditionally used in Mexico involving cooking and steeping maize in calcium hydroxide and water provides health and nutritional benefits, including: 1) Reducing aflatoxin levels, 2) Reduction in pellagra disease risk, 3) Increasing calcium intake, supply of dietary fiber and bioavailability of iron and zinc. Using the Smartgrid model as framework, this project aims at characterizing the maize food system in Kenya to assess the value of adopting the nixtamalization technique as an instrument to increase diversification of products for purposes of enhancing nutrition, health, and income generation, thereby enhancing food security and poverty reduction. By doing this, the potential systemic impact of the adoption of the technique will be outlined at the local, national and regional levels.

2. Introduction

Although maize is a staple food in Kenya, the nutrition transition that is occurring in developing countries is due, among other reasons, to the shift toward greater availability of fats and sugars and reduction in reliance on starchy carbohydrates, especially in the urban areas. Thus while food environment has changed dramatically especially in urban areas of developing countries, offering diversity and opportunities for consumers, the urban poor have several challenges that may threat their access to high-nutritional quality, diverse and affordable diets, increasing the risk of hunger, malnutrition or over-nutrition.

Nutrition transition is occurring mainly in urban areas, where dietary patterns and life-style are different from the rural areas. Urban populations tend to consume more meat and less dairy. In general, they also consume more fruits and vegetables, although consumption of these food groups depends on the economic status of the people. Urban dwellers consume more non-basic foods, including sugary snacks, street food, and processed foods.

Food processing methods that contribute to enhance the nutritional benefits of the ingredients, like the case for maize kernels in nixtamalization, should be promoted in conjunction with other public policies.

3. Case Study

a) Resource sustainability and resource efficiency.

Even though maize supplies many macro- and micronutrients necessary for human metabolism, the amounts of some essential nutrients are inadequate for consumers in sub-Saharan Africa (SSA) that rely on maize as a major food source. The quality of the produced and consumed maize is therefore a critical factor to address food security concerns in the region. Anchored in the findings of current scientific research on the benefits of nixtamalizing maize, the proposed research argues that a there is a “match” between the specific nutritional and health needs of the majority of Kenyans and the gains that can be obtained by adopting this processing technique. In addition, considering the importance of diversification and enhancement of the nutrient content of maize products, conceivable options for nixtamalized (bio)-fortified flour will be discussed.

b) Socio-economic realities

Maize was introduced in Kenya by the Portuguese in the 16th century and has been since then a staple crop. Whereas Mexico, center of maize diversity, has more than 600 food products from it, Kenya can hardly count more than 10 uses of maize. Maize in Kenya is prepared as kernels either whole or decorticated. Whole kernels are prepared by boiling in admixture with beans and then stewed with potatoes or green vegetables. This mixture is called *Githeri*. In some communities, the mix is boiled with ash, which makes the kernels turn yellow and tastier than those boiled with plain water. The decortication is carried out by three methods: 1) Wet decortication by pounding in a mortar with pestle and winnowing off the detached pericarp, 2) Machine decortication by using mechanical abrasion and 3) Boiling in alkaline infusions from ashes obtained from maize cobs,

bean trash etc. In urban areas, maize is also milled into meal of extraction rates ranging from about 70 –100%, and used for preparation of *ugali* and sometimes porridge. Whole grain green maize is often roasted or boiled on cob for consumption.
Maize meal consumed in the rural areas is supplied from milling on small scale using small village hammer mills (posho mills). Posho flour has inferior-quality and it is commercialized at cheaper prices for price-sensitive consumers.
The triple burden of malnutrition is present in Kenya, a country with more than 13% of the population under-nourished, about 22% of women overweight and about 35% of the children less than 9 years stunted. More than 60% people of Kenya live below the poverty line (less than $1.25 a day or unable to afford to buy food providing a daily intake of 2,100 kilocalories). Although under and over nutrition co-exist at the household level especially in poor urban areas, there is a prevalence of under nutrition in the rural areas and over-nutrition in the urban areas. In cities like Nairobi, supermarkets with a variety of fruits, vegetables and dairy products, serve primarily households in the top 20 percent of income distribution. Street foods can make up a significant part of the diet for example in Nairobi, about 61 percent of men in one low-income neighborhoods regularly purchased street food for lunch, which contributed to more than 40 percent of their daily energy intake.

c) Food Processing

Nixtamalization is a food processing that can be done at house-holds and small, medium and large industry.
The ingredients needed are simple, water, lime and maize kernels. However, in addition to maize, it is also possible to nixtamalize other grains and legumes like oats, peas, amaranth, etc. Cost of the process will depend on the availability of such inputs and the level of the processing.
For countries like Kenya, the use of nixtamalization will not only bring maize product diversification and the consequent diet diversification but also nutritional enhancement of the maize-based food products and opportunities for income generation.
Given the relatively high pH of the food products like tortillas, it is well established that the shelve life of the tortilla is more than 5 days, which brings a benefit as compared to the shelve life of ugali or porridge (a usual maize food product consumed in Kenya), and it might contribute to reduction in food waste. The potential reduction of aflatoxins (fungi toxins) by nixtamalization could also contribute to the reduction of maize wasted due to the presence of these toxins.
Two of the main limitations of nixtamalization are the amount of water being used in the process and the liquid waste that it produces. However, medium and large industries in Mexico are already using optimized process or are treating the residuals before discarding them to the sewerage systems.

d) Correlation of food-production system with food-consumption system.

Kenya ranks 29th in the global production of maize (about 3,500,000 tons per year). About 10% of the country's maize is going for feed use and 90% for food. Maize is produced in rural areas and consumed locally or transported to the cities like Nairobi for its transformation in to flour to prepare ugali and porridge.
There are several governmental regulations that aimed at promoting the Kenyan maize production and strengthening the local industry (including ongoing agricultural interventions on several fronts). Along with food safety, the dominance of smallholder farmers, government market intervention, regional trade and food security are all key aspects of the maize economy.
This project will analyze available production and economic data to contextualize the proposed introduction of the nixtamalization technique as an instrument to increase diversification of products for purposes of enhancing nutrition, health, and income generation, thereby enhancing food security and poverty reduction. Among others, to be considered are the following: varieties and characteristics of commonly produced and consumed maize; current storage and post-harvest practices; available maize processing technology (micro-industry) and methods, state of the local milling industry; distribution channels; and marketing and commercialization practices.
The commercial maize flour in Kenya is about $315.8 million and it is expected to increase to $444 in 2020 while posho maize flour will increase from $658.2 million in 2015 to $840.2 million by 2020.

e) Future developments (3-10 years)

- Addressing nutritional deficiencies and public health concerns, in particular, for vulnerable groups (children; pregnant women, etc.)
- Bringing innovation to maize processing, marketing and distribution channels.

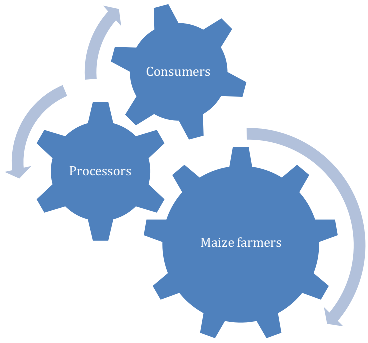
- Improving general economic conditions by strengthening the Kenyan maize industry;
- Promoting local and regional economies by strengthening economic opportunities development, enhancing employment and improving socio-economic wellbeing;
- Generating new commercial business and investment opportunities and industrial equipment manufacturing capabilities.

f) Proposed actions to address the criticalities and/or strengthen potential (today – 10 years)

- The technique and technology involved at the core of the nixtamalization process is simple and accessible, adaptable and easily replicable and scalable.
- Adoption of the nixtamalization technique can easily follow market oriented models, adapted to the locally (or regionally) available resources, as well as local and regional market conditions;
- Behavioral communication campaigns and dissemination efforts of the technique can be designed to be inclusive (engaging most vulnerable groups and communities not only as consumers, but also as suppliers, employees and entrepreneurs).
- Sustainable, cost effective and financially viable enterprises can flourish around the nixtamalization technique.
- Governmental regulations can be changes and/or developed to promote this industry's economic development and to promote more effective agricultural and economic interventions.
- Lastly, and most importantly, nixtamalization can have an important impact both at the social level, as well as at the individual level.

4. Conclusion

By introducing nixtamalization as an alternative to process and consume in Kenya, the whole maize value chain can be positively affected. Farmers can have market opportunities in both rural and urban areas, processors can develop new range of products and consumers can have access to nutritionally enhance maize food products.



A better understanding on the effect of nixtamalization on the aflatoxin content in maize-based food products will be crucial to expand further the opportunities of nixtamalization in human health.
Nixtamalization adoption in Kenya can bring more alternatives to consume maize, less options to waste food or to adopt non-healthy diets.

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Tourism challenge on small-scale agribusiness in Bali

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1. Summary

Bali is a small island and a small province in Indonesia, known in the world as a tourist destination, with visitors tending to increase every year. In fact, the number of tourists nearly tripled in 2016 compared to the residents of Bali, which are approximately 4.2 million. This indicates a significant movement of dynamic consumers and needs related to foods, that have to be fulfilled mostly by small-scale agribusiness in Bali. The highland of Bedugul is known as the center area of vegetable production. The production is occupied by small scale family farmers and is linked to small scale agribusiness distribution chain systems. The case study indicated that the systems are still inefficient and ineffective in creating the values emerging in dynamic modern consumers/markets. The farmers tend to exploit their lands by using hybrid seeds and making intensive use of agrochemicals. These practices however, go against the concerns of dynamic modern consumers regarding issues such as food safety, declining biodiversity and environmental destruction. This inefficient and ineffective production, caused skyrocketing of land prices and changes in life style, which have threatened the agriculture sustainability in the Bedugul area.

2. Introduction

The small island of Bali is one of 17,000 islands in Indonesia. About 90% of the 4.2 million people of Bali are Hindus, who created unique traditions and cultures and positioned Bali as one of the top-ranking tourist destinations in the world. The philosophy of life of Balinese to live in harmony is framed by three pillars of good relationships, namely the relationship between humans (sociological aspect), between humans and the environment (ecological aspect), and humans with God (spiritual aspect), known as TRI HITA KARANA. This philosophy is believed to have created the unique traditions and cultures. Agriculture activities are also inspired by the TRI HITA KARANA and are therefore an attraction for tourists. During the last decade, the number of tourists who visited Bali increased significantly. By 2016, they amounted to approximately to 4.9 million foreigners and 7.9 million domestic tourists, compared to the inhabitants of Bali, which are just about 4.2 million (Bali Central Bureau of Statistics 2017).

The high mobility of people in the tourism sector has brought changes in the agricultural sector in Bali. The increase in accommodation and services, which have to be provided for tourists, has threatened the existence of agriculture lands. The significant increase of land price and change in lifestyle of Balinese people, brought about the interaction with global tourism, has triggered the shifting of land use from agricultural to non-agricultural purposes. The Agriculture Census indicated in 2013 that every year about 3,617 ha of agricultural land were shifted to non-agricultural purposes during the period of 2003-2013.

Tourists coming to Bali and bringing their own food traditions, changed the activities in agriculture, which are mainly carried out by small scale farmers. The change was from self-sufficient oriented production to commercial production in order to respond to the demands of the dynamic change of consumers/markets, including institutional consumers (hotels, restaurants and catering services). How far can the existing agriculture system respond to the rapid development of tourism in Bali? It is interesting to study this, and in particular, to study the impact of tourism in Bedugul, the area known as the center of production of many species and varieties of vegetables. Small-scale family farmers in this area are largely responding to adapt to the needs of institutional consumers and modern markets. The area is a valley, or crater located in the center highland of Bali, and climate, soil and the availability of water created conditions that are suitable for growing different species/varieties of high value vegetables.

3. Case study

Bedugul is a 3,942 ha valley consisting of two villages, namely Pancasari and Candikuning, located in the mountains (1200-1500m asl) between Tabanan and Buleleng districts. Pancasari village is governed by the district of Buleleng, and Candikuning by the district of Tabanan. The night air temperature in the area can reach 18^{o}C and at noon 24^{o}C. The average rainfall is about 19.20 cm and the humidity ranges from 60% to 90%. From September to February, the rainfall is relatively high (rainy season), while from March to August, the rainfall is relatively low (dry season). There are two lakes in the valley, namely Beratan and Buyan. Another lake, Lake Tamblingan, near Lake Buyan, is not in the valley of Bedugul. With good climatic conditions and supported by dominantly regosol soil, various high value vegetables and herbs species/varieties can be grown in the area.

The number of households in the two villages is about 3,400, of which approximately 80% work in the agricultural sector. The average farming area of a family farm is 0.35 ha, cultivated with horticultural crops, and, up until recently, predominantly local highland open pollinated crops, such as cabbages, celery, potato, carrot, tomato, cucumber and chili. However, with the development of tourism, the variety of vegetables increased and cultivation is now dominated by hybrid crops. Moreover, most local seeds have been replaced by hybrid ones. In accordance with the needs of tourists, different species of herbs have also been developed

More than 100 species/varieties of vegetable crops and commercial herbs are now cultivated in Bedugul area in response to consumer demands in the tourism sector. Such numbers of vegetables and herbs are not being cultivated in other locations in Indonesia, where tourism is less developed. The small-scale family farmers in Bedugul are flexible to choose crops that can grow in rainy or dry season. They mostly cultivate different species or varieties of crops in their own lands with intensive family involvement. In the dry season, in some lands far away from a water resource, farmers are even willing to buy water for crop irrigation at an additional cost of IDR 750,000 to IDR 1,500,000 per month.

The response of family farmers to dynamic demands of institutional consumers and modern markets has required the intensive use of agrochemicals both, in open farms, and in simple green houses made from woods and bamboos. The simple greenhouses are generally used to grow bell pepper, strawberry and cut flower of *Chrysanthemum*. Siaka et al. (2004) reported that the edible parts of leafy vegetables i.e. cabbages, mustard greens, lettuce, broccoli, and spring onion grown on open land, contained concentrations of heavy metals Pb, Cu, Cr and Zn higher than those permitted by FAO / WHO. They concluded that the soil in the Bedugul area has been polluted by heavy metals. Another indication of the high use of agrochemicals was found in the contamination of lake Buyan (Manuaba, 2008 and 2009). The contamination by organic phosphate pesticides (dimethoate, Chlorpyrifos and profenofos) was identified for a total of 14.9 ppb, and carbamate (carbofuran and methomyl) for a total of 15 ppb. This suggests that the farmers are trying hard to protect their crops and to secure production for family incomes, even though the adopted practices are endangering the environment, biodiversity and consumers, or are in contradiction with sustainable agricultural practices.

The study conducted by Utama and Kitinoja (2015) found that there are five vegetable distribution channels from the Bedugul area to different markets or consumers, as shown in *Figure 1*. Based on eight criteria developed by Collins (2009) in assessing the value orientation of the distribution channels, it was found that distribution chains 1-3 were very weakly value oriented. A total of 75% of production was through chains 1-3. The long distribution chains 2 and 3, in which about 60% of products are delivered, cause high losses, higher than the losses in the 1st short distribution chain. The losses in the city traditional markets were found to be higher than the ones in village traditional retail markets. The differences were due to a longer transportation time, and higher quality preferences shown by the consumers in city traditional markets. In *Figure 1*, one can see, that losses/wastages at the farm level, especially in the field, are relatively high (5-10%). This high loss was due to product defects, attack by pests and diseases, and because the sizes or forms did not meet the standards of commercial markets. In the distribution chains 1-3, there was a weight deduction, performed by the buyer or collectors in the range of 5-10%, depending on the perishability of vegetables. The deduction is for the compensation of damages during handling and transportation.

Distribution chains 4 and 5 are more value oriented, but they still need to be strengthened, in line with an increase in market sophistication, especially in order to create intrinsic and extrinsic quality. Only 25% of the vegetables and herbs from Bedugul were delivered through chains 4 and 5. The calculation of losses of 10% in the modern market was due to the risk of damages, trimming before products are tied, or packing into retail units, as well as unsold products (wastages). The losses are the responsibility of the suppliers. Instead of a 10% automatic deduction, one multinational supermarket in Bali charges suppliers with 8.3% of total fresh produce for offering regular discount (3.5%) and tax rebates (1%) on the products, promotion budget (1.5%), anniversary support (1%), Eid support (1%) and packaging cost (0.3%)

Figure 1. Distribution channels and losses of vegetables produced in the area of Bedugul, Bali.

This illustrates the conditions of the value oriented vegetable production systems and distribution channels in the Bedugul area. On the consumer side, there is a significant dynamic change, in line with the increase of tourism in the last two decades. In 2016, the number of foreign and domestic tourists coming to Bali approximately tripled compared to the number of residents, about 4.2 million people (Bali Central Bureau of Statistics 2017).

By 2016, 323 star hotels and 1798 non-star hotels were established to accommodate the number of tourists coming to Bali. This indicates that there is a significant movement of people, with diverse food traditions entering Bali, who need to be fed during their stay in Bali. A total of 2,223 restaurants opened by 2016 to provide food services to tourists, as well as to Bali residents. There is also a significant change of life style among Balinese, in particular toward the food they consume. This is accompanied by an increase of their knowledge about the meaning of nutritional values and food safety. In other words, there is a tendency to change the pattern of food consumption from traditional to modern consumers.

Vegetable suppliers from Bedugul have recognized that the consumer's values are higher. Some star hotels reported requests of extrinsic food qualities, such as food safety certificates to protect their consumers, and eco-labeling to show their concern about environmental exploitation and destruction (*Table 1*). This indicates that the market competition to fulfill the needs of modern consumer in Bali is high and can only be met by a system of modern and integrated agribusiness creating those values. Currently, 60% of the vegetable supply for institutional consumers and modern markets comes from outside Bali, including imports.

Types of Markets	Characteristics of market demands
Traditional market	Affordability and price are dominant
Modern markets, international hotels, restaurants and catering services	Intrinsic quality is dominant
Some international hotels and restaurants	Intrinsic and extrinsic quality factors

Table 1: Quality consideration and market sophistication of different types of end markets for fresh vegetables and herbs in Bali.

With small scale agribusiness systems, weak value orientations and relatively high losses, the agribusiness chains of vegetables from Bedugul, are inefficient and ineffective to compete with the dynamic market in Bali itself. The inefficiency and ineffectiveness of small-scale agribusiness systems, accompanied by a sharp increase in land prices, high labor costs, and change of lifestyle, will continue to support the conversion of land from agriculture to non-agricultural purposes and hence threaten sustainable agriculture in Bali. Therefore, efforts to strengthen or develop small-scale agribusiness systems in creating dynamic consumer values in Bali are important. A system approach creating values by establishing integrated value chain systems including small-scale holders, has to involve different parties. Institutional consumers (hotels, restaurants and catering services) and modern markets, reflecting resident-modern consumers are important parties and have to be seen as value drivers. Actors involved in the business chains, such as farmers in the production, intermediaries or suppliers, processors, can be seen as value creators. Supporting systems, such as seeds, organic and non-organic fertilizers and pesticides, financial institutions, simple machinery and equipment providers, research and technological development institutions, have to be seen as important supporters in creating value chains. The government is important in developing policies to secure and protect the system supporting its sustainability and securing benefits for all parties involved in the agribusiness value chains.

4. Conclusion

The significant development of tourism in the last two decades has brought a dramatic shift of land use from agricultural, to non-agricultural purposes. This is triggered by the increase in land prices and the inefficiency and ineffectiveness of small scale agribusiness chains in facing dynamic changes in the demand of values by institutional and modern consumers. Bedugul, an area known to produce different species and varieties of highland vegetables and herbs by small scale family farmers, has been facing exploitative land use in order to fulfill the high demands of institutional and modern consumers. This exploitation is in contradiction with the growing concerns of exactly those consumers. The inefficiency and ineffectiveness of the existing agribusiness distribution chains in creating modern market/ consumer values, threatens the horticultural production in Bedugul. The improvement of the existing agribusiness chain system, which includes small-scale holders, to a strongly value oriented system is required. A system approach, involving all related parties, has to be adopted.

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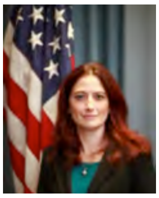

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Post Workshop Analysis

Boston: a hub/spoke model of urban agriculture

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1. How can the smartgrid be applied to the food system described in your case study, and which benefits would it bring to the specific challenges you describe?

There are several ways:

1) reduce land costs
2) Reduce energy costs
3) Reduce input material costs
4) Reduce transportation costs

The best ways to do this are to link food production distribution and waste management to other urban infrastructure (energy, water, waste, housing, transportation) because otherwise it is too costly and intensive for urban agriculture to be economically and environmentally sustainable.

The smartgrid will also save time, cut administrative costs, reduce redundancy, build trust and help avoid conflicts and facilitate coordination, collaboration and cooperation among the stakeholders- especially information sharing about growing techniques and problem solving.

2. Which process innovation and/or technological innovation is/are required for the development of a smartgrid?

To develop the smartgrid, there is a need for a series of innovative charrettes designed to systematically identify and introduce stakeholders to the idea, discover what may already exist in terms of data/information and where it resides. Then there is the actual design of the IoT platform, and the need for a common "language" and data sharing protocols. In terms of technological priorities, technologies that capture the waste or output from one resource as inputs for the next, building a circular bio-inspired efficiency that captures and reuses generated heat, energy, water, nutrients, carbon, and carbon dioxide will require both technology and process innovations. These may also need to be integrated into building and/or transportation infrastructure to achieve adequate efficiencies.

3. Could the design of new processes, as well as the development of new, or already existing technological applications, specific to your case studies, be transferred to other food systems/ challenges (consider both, food systems described in the workshop as well as new ones)? Could this transfer benefit also other socially different realities (consider also the possibility of reverse transfer)?

The process and technology innovations are envisioned as easily transferable technologies, particularly in developing economies, where combined food, water, energy, transportation, housing, shopping infrastructure can be designed and planned *de novo*. As an example, a building with an HVAC system relying on solar power, providing heat for food growing, and electricity to purify building waste water for reuse as irrigation supply, that also supplies electricity, heating and cooling to residents and businesses. Hydroponic systems; low-cost climate control structures (*e.g.* greenhouses covered with mesh are used in some countries to help keep crops from overheating and cut down on the need for water).

Simpler systems for slower developing economies still can use combined waste/water/energy technologies such as anaerobic digestion/composting to capture biogas, manage food waste, and produce water for irrigation and nutritious compost for food growing.

Investigating existing systems through the smartgrid approach will help identify alternatives and the current state of knowledge toward acceptable/state of the art practices in this regard.

4. Which knowledge gaps should primarily need to be addressed?

- Social acceptance of technologies
- Current food systems and state of the art
- Nutrition of foods grown in engineered environments
- Technology risks in combined systems (e.g. Contaminants in waste and waste water, electric power interruptions, biogas safety)
- Financing options/strategies

Impact of social and climate changes on rice production in Middle Casamance, Senegal

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Summary: The case study on rice production in Casamance analyses a high-potential sector, born of a long tradition of rice cultivation, but also of a diet in which rice occupies the main place. The rice produced by women symbolizes a considerable contribution to the household's food needs and security. Today, this traditional production system faces the challenges of various risks, that can be minimized through an accessible and sustainable strategy for food and economic security of households.

1. How can the smartgrid be applied to the food system described in your case study, and which benefits would it bring to the specific challenges you describe?

In our approach the smartgrid can be seen as a common framework, within which learning spaces at multiple levels, and involving multiple actors, can be developed. The smartgrid could help addressing the complexity of the food system as well as its relations and interactions with other levels (national/global) and actors (buyers, suppliers, development agencies). Furthermore, it could have a tremendous impact in the context of food security, linking information and actors along its main pillars: Availability, Access, Quality. The smartgrid can provide the framework for Agricultural Innovation Systems as systemic learning process.

2. Which process innovation and/or technological innovation is/are required for the development of a smartgrid?

The smartgrid builds on a better connection among decentralized local systems on multiple layers. Each local system is characterized by local needs and local resources. The smatrtgrid should provide a common framework for ICT solutions, data and information management, as well as learning spaces (virtual and concrete). Within the case study, this mechanism involves the innovation of cropping techniques and of the current agricultural system and should be adaptable to different environmental and social contexts, a fundamental prerequisite for achieving positive results despite the lack of technical and human resources.

3. Could the design of new processes, as well as the development of new, or already existing technological applications, specific to your case studies, be transferred to other food systems/ challenges (consider both, food systems described in the workshop as well as new ones)? Could this transfer benefit also other socially different realities (consider also the possibility of reverse transfer)?

Yes, even if innovation is a learning process that should be adapted to the context, learning from failures and good practices acquired within other experiences is fundamental for the design of new processes. The case studies presented at the Foresight workshop differ in their social, cultural and economic specificities, etc., however, the methods used to overcome the challenges can be adapted to different contexts. Furthermore, the same problems may arise in other places, in other forms. The idea is to draw inspiration from the realities that emerge at different levels of development and to study the capacity of populations to integrate different possible solutions, of course, adapting them to the context in which they are confronted. The aim is not to replicate the situations that occur elsewhere, but to adapt the means used according to the area of action, while avoiding creating an imbalance between innovation and the ability to assimilate innovation by target actors.

4. Which knowledge gaps should primarily need to be addressed?

Concerning our case study priorities are work organization, collaboration, cooperation among farmers and other actors. New approaches in extension system based on multiple actors, including public, private and cooperatives, should be found in order to ensure the sustainability of innovation introduced at technical agronomic level.

Expanding Maize Utilization as Food through Mexican Processing to enhance Nutrition, Health and Development in Kenya

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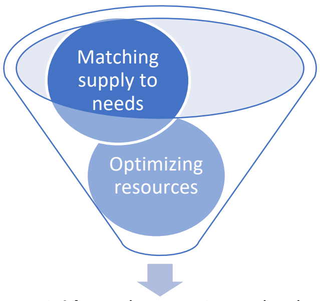
Summary: Using the Smartgrid model as framework, this project aims at characterizing the maize food system in Kenya to assess the value of adopting the nixtamalization technique as an instrument to increase diversification of products for purposes of enhancing nutrition, health, and income generation, thereby enhancing food security and poverty reduction. By doing this, the potential systemic impact of the adoption of the technique will be outlined at the local, national and regional levels.

1. How can the smartgrid be applied to the food system described in your case study, and which benefits would it bring to the specific challenges you describe?

The application of the smartgrid to this case study can support the issue of matching the supply of maize to the needs of the consumers and of optimizing the resources towards a new processing technology, that can bring nutritional benefits to the population.



SmartGrid: Food processing technology from Mexico to Kenya

2. Which process innovation and/or technological innovation is/are required for the development of a smartgrid?

The smartgrid links food chains and in this case it should contribute with a framework for farmers, processors and consumers. Transfer and development of the nixtamalization process in Kenya will require monitoring and evaluating of supply chain data, adaptation of technologies (maize grain, mills) to local resources, and connection of capacities and needs between processors and consumers.

3. Could the design of new processes, as well as the development of new, or already existing technological applications, specific to your case studies, be transferred to other food systems/ challenges (consider both, food systems described in the workshop as well as new ones)? Could this transfer benefit also other socially different realities (consider also the possibility of reverse transfer)?

Of course, the success of the introduction of the technique in Kenya can be extended to other African countries where maize is a staple crop and maize-based food products are very limited. This could be a great example of a South-South intervention where a technology from Mexico can be transferred to Africa.

4. Which knowledge gaps should primarily need to be addressed?

Acquisition and evaluation of available production and economic data to contextualize the proposed introduction of the nixtamalization technique as an instrument to increase diversification of products for purposes of enhancing nutrition, health, and income generation, thereby enhancing food security and poverty reduction. Among others, the issues to be considered are the following: varieties and characteristics of commonly produced and consumed maize; current storage and post-harvest practices; available maize processing technology (micro-industry) and methods, state of the local milling industry; distribution channels; and marketing and commercialization practices.

The vegetables local varieties in Puglia (Italy): a legacy from the past and a heritage for the future

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Summary: The case study describes the increasing trend of actions and the renewed interest toward the characterization, preservation and enhancement of the agro-biodiversity (local varieties, local knowledge, local traditions) of Puglia region (Italy), with a specific focus on vegetables.

1. How can the smartgrid be applied to the food system described in your case study, and which benefits would it bring to the specific challenges you describe?

The use of the local vegetable varieties is strongly connected with the local dimension of the food system. This typical representation of agro-biodiversity survived in Puglia to the so-called green revolution in agriculture, but the threat to lose considerable portions of it (both in terms of genetic resources and of knowledge) has been, and still is, serious. The integration of this important biodiverse food system in a smartgrid system would help its full exploitation. A smartgrid approach should act on:

- a more effective organization and integration of activities related to the preservation of the genetic resources, acting on the local seed industry, promoting the creation of more stable and effective connections among the seed savers growers, and facilitating the role of the scientific institutions;
- generating an information flux able to match consumers demand to the offer of local products;
- giving more visibility to local varieties, enhancing the consumption of this nutritious and locally produced food, and preserving the link with our identity and our environment.

2. Which process innovation and/or technological innovation is/are required for the development of a smartgrid?

A smartgrid should ensure the communication and the effective share of knowledge and information among the actors of the food system. On one hand, the smartgrid should represent a facilitating environment for the co-creation of innovative knowledge and for decision-making, on the other hand it should make innovations available to all actors (producers, consumers, retailers, policy makers). To be fully accomplished, the smartgrid approach requires a full change of paradigm, but it can also start by acting on selected parts of the food system. In the present case study, and at this stage a smartgrid could help to set up a dynamic mapping of the availability of local genetic resources; later on, the grid should involve mapping the needs of the population and addressing the local production at local nodes level.

3. Could the design of new processes, as well as the development of new, or already existing technological applications, specific to your case studies, be transferred to other food systems/ challenges (consider both, food systems described in the workshop as well as new ones)? Could this transfer benefit also other socially different realities (consider also the possibility of reverse transfer)?

The preservation of agro-biodiversity has been recognized as a key-factor for the future food security. Sustainable use of resources cannot exclude the preservation of agro-biodiversity resources. In many areas of the world there is still a strong connection between food and local agro-biodiversity, so its preservation represents an important opportunity for the development of innovative food system concepts.

4. Which knowledge gaps should primarily need to be addressed?

Priorities in this case study are: to enhance the local seed industry aimed to support local varieties propagation and material availability; to act on consumers in order to consolidate in new generations the consumption of local vegetables, both as part of our identity, as well as for the high nutritional value of these products; to study new occasions of business for growers using local varieties.

The Integrated Production system in Emilia Romagna region (Italy)

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1. How can the smartgrid be applied to the food system described in your case study, and which benefits would it bring to the specific challenges you describe?

The Integrated Production system in Emilia Romagna (ER) region seems to be a rather good example of a food system that can be well adapted to the Smartgrid concept, in particular if the main key words for a smartgrid are "Process, Engagement, and Data" (at local/regional, national, and global level) .

However, although the ER food system, compared to other systems described during the workshop, could be considered a success story of a sustainable and robust system, many weakness/challenges need to be addressed, such as low funds to update properly the IPGs, which are a core tool of our system; discontinuous political support; low capability of some actors to define common long view strategies to influence, and possibly drive, some market choices. The application of the smartgrid concept can help address these challenges.

2. Which process innovation and/or technological innovation is/are required for the development of a smartgrid?

The key challenge is represented by the development of a newly designed process, that will upgrade the ER agricultural system following a general concept of resilience, adaptability to climate changes, food requirements (e.g., nutritional and nutraceutical aspects, specific dietary needs, ….), sources availability, and added value on food production.
The ER system, which is a local/national system, becoming part of the grid could for example:
- get additional data from other similar systems, although far away;
- improve its extension service thanks to a larger net of information systems, tools and DSS;
- upgrade its competitiveness on the market;
- get market information and be able to address exceedance of production to different markets;
- integrate new crops/varieties production, better responding to the new nutritional requirements of consumers and food industries;
- export (and import?) not only products, but also competences to other, in particular young agricultural areas.

3. Could the design of new processes, as well as the development of new, or already existing technological applications, specific to your case studies, be transferred to other food systems/ challenges (consider both, food systems described in the workshop as well as new ones)? Could this transfer benefit also other socially different realities (consider also the possibility of reverse transfer)?

Some aspects of this case study could represent a training system that could serve as an example of implementation/adaptation within other local contests (e.g., engagement of different actors occurred since the beginning of the process system, process followed and supported by tools and services, a large amount of data collected, available and used). On the other hand, this food system can take advantage from the smartgrid and other new processes and/or technological applications in order to improve itself (cross feeding), adapting to a future scenario of food needs, according to sustainability, health and food security.

4. Which knowledge gaps should primarily need to be addressed?

Analyzing the ER case study, possibly within a specialist network, could simplify the identification of key problems and allow finding more appropriate solutions within a learning space.
Although it is hard to change people's mind, a well-developed, practical and reliable new approach, to address future goals such as sustainability, health and food security, and which shows an added value for food producers, could be a driver for change.

Tourism challenge on small-scale agribusiness in Bali

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1. How can the smartgrid be applied to the food system described in your case study, and which benefits would it bring to the specific challenges you describe?

As mentioned in the case study of "Tourism Challenge on Small-scale Agribusiness in Bali", there is a significant movement of people in Bali, in particular of tourists with different food traditions, according to their country of origin. The change of life style of the Balinese people themselves, due to their adaptation to these new inputs, brings about a change of consumers habits, from traditional to modern consumers. That means that there is a dynamic change of consumer's values, which have to be fulfilled by food producers and food suppliers. The assessment of the small-scale agribusiness chains of vegetables produced in the area of Bedugul, indicated that these chains are still less value oriented or traditionally connected and that the transactions between the chains are still dominated by price rather than value. These chains are weak in competitiveness. Therefore, there is a need for improvement or for strengthening the existing agribusiness chains, for them to become value oriented in an integrated value chain system. Modern markets and institutional consumers (hotels, restaurants and catering services), which reflect the values of dynamic modern consumers, could be used as value drivers in developing integrated-sustainable agri-value chain systems. The values, which normally emerge in modern markets and institutional consumers, are quality (intrinsic and extrinsic qualities) and services. It is the responsibility, (even financially) of the leadership to identify those chain activities that could be improved and make them more efficient, to increase efficiency of the whole value chain system. However, to make the value chain effective in creating those values, a control system should be established across the chains. Furthermore, a supporting system, that assures that the processes in the main system can be performed in sustainable ways, and are based on the created values, has to be made available. In the production, for example, availability of seeds, organic fertilizer, and bio-pesticides, water for irrigation, cost-effective technologies, etc., should be available.
Research and development institutions have an important role in the development of innovative and adaptive technologies, e.g. facilitating an integrated management system, developing the capacity of human resources, etc. The government role is to develop policies on how institutional consumers and modern markets could work together for the benefits of consumers and actors within the value chains. Policies should assure the consumers and guarantee that they get the values needed in terms of intrinsic quality (such as freshness, nutritious and organoleptic satisfaction), as well as extrinsic quality (such as food safety certification and eco-labeling). In other words, certification of the overall system by a third-party certification body has to be facilitated by the government, especially regarding the cost; while the technical preparation for the certification can be facilitated by research and development related institutions.

2. Which process innovation and/or technological innovation is/are required for the development of a smartgrid?

The process innovation is represented by the integration of controlled-value activities involving small-scale farmers, intermediaries, and institutional markets/modern markets, to fulfill the changing demands of modern consumers.
This innovation involves small-scale farmers and intermediaries. Therefore, the technologies required to develop the values mentioned above have to be simple-adaptive, efficient (low cost), effective and eco-friendly. R&D is necessary to develop those innovative technologies in the production, postharvest handling and storage, and distribution. R&D is also needed to develop strong supporting systems.

3. Could the design of new processes, as well as the development of new, or already existing technological applications, specific to your case studies, be transferred to other food systems/ challenges (consider both, food systems described in the workshop as well as new ones)? Could this transfer benefit also other socially different realities (consider also the possibility of reverse transfer)?

In the era of globalization where there is a significant movement of people from one place to another, or from one country to other countries for tourism or other purposes, what occurs in Bali could also happen in other places in the world. Therefore, a model system developed in Bali could be transferable to other societies in different countries.

4. Which knowledge gaps should primarily need to be addressed?

In the current literature, a value chain system mostly discusses systems involving large-scale farms, industries, logistic and investment.

The specific Bali case study develops and explores new knowledge on how to improve or develop an agribusiness chain system involving small-scale farmers. It investigates how to support them in facing dynamic changes of institutional consumers with different food traditions, as well as modern markets. The improvement of the traditional agribusiness, to a value oriented agribusiness chain system is rarely discussed and likely to be a new knowledge, which could be of benefit for community development in other places or countries.

Precision Urban Agriculture

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Summary: precision urban farms for low income urban populations

During the CNR Foresight meeting in Anacapri, Italy staff from the Institute for Transformative Technology presented a case study of the potential of precision urban agriculture in a mid-sized urban city in the United States—Oakland, California. This case study was structured to:

- Understand the potential impact and challenges for precision agriculture within an urban environment.
- Understand the building blocks within the urban environment that would need to be engaged for precision agriculture to enhance healthy food access for low income urban populations.

This follow-up focuses on key questions posed by the Foresight work shop organizers to all case study developers.

1. How can the smartgrid be applied to the food system described in your case study, and which benefits would it bring to the specific challenges you describe?

Given the high capital investment costs and running costs of precision agriculture systems creating an economic model which can sustainably reach low income populations will require not only innovations in growing technology but changes to packaging, processing and distribution and avoidance of waste and spoilage. Economic viability will be dependent on using the smart grid approach to get just in time delivery to a customer base—utilizing existing public systems and programs as a delivery base.

2. Which process innovation and/or technological innovation is/are required for the development of a smartgrid?

As described above the components of the smart grid within our case study are:

- Growing systems: New precision agricultural growing system (using hydroponics or aeroponics and controlled environments) able to grow at high density within a small physical footprint.
- Packaging and processing: Streamlined packaging and processing—which are designed to lower costs by taking advantage of short distance to consumer and short-time from harvest to delivery.
- Distribution: New distribution systems using publicly funded programs (e.g. schools, early childhood programs, homevisiting programs and transit hubs) as part of a delivery system to get produce directly to low-income consumers.
- Waste avoidance: Waste comes in multiple forms in our current agricultural systems:
    - Crops which are ruined because of pests, blight, weather or other environmental conditions.
    - Crops which never make it to market because they are imperfect, of the wrong size, blemished, or for which there is too much supply for current demand.
    - Crop spoilage and damage during processing, packaging, and delivery.
    - Crops that are left unpurchased in retail outlets.
    - Crops that are purchased and uneaten.

Within our model precision agricultural systems will minimize waste by:

- Minimizing crop loss, imperfection and unacceptable variability
- Using predictability and control of the production cycle to better synchronize demand and supply.
- Reducing loss in processing, packaging and delivery based on shorter distance to consumer.
- Using direct/just-in-time delivery to consumer to reduce losses of unpurchased or uneaten produce

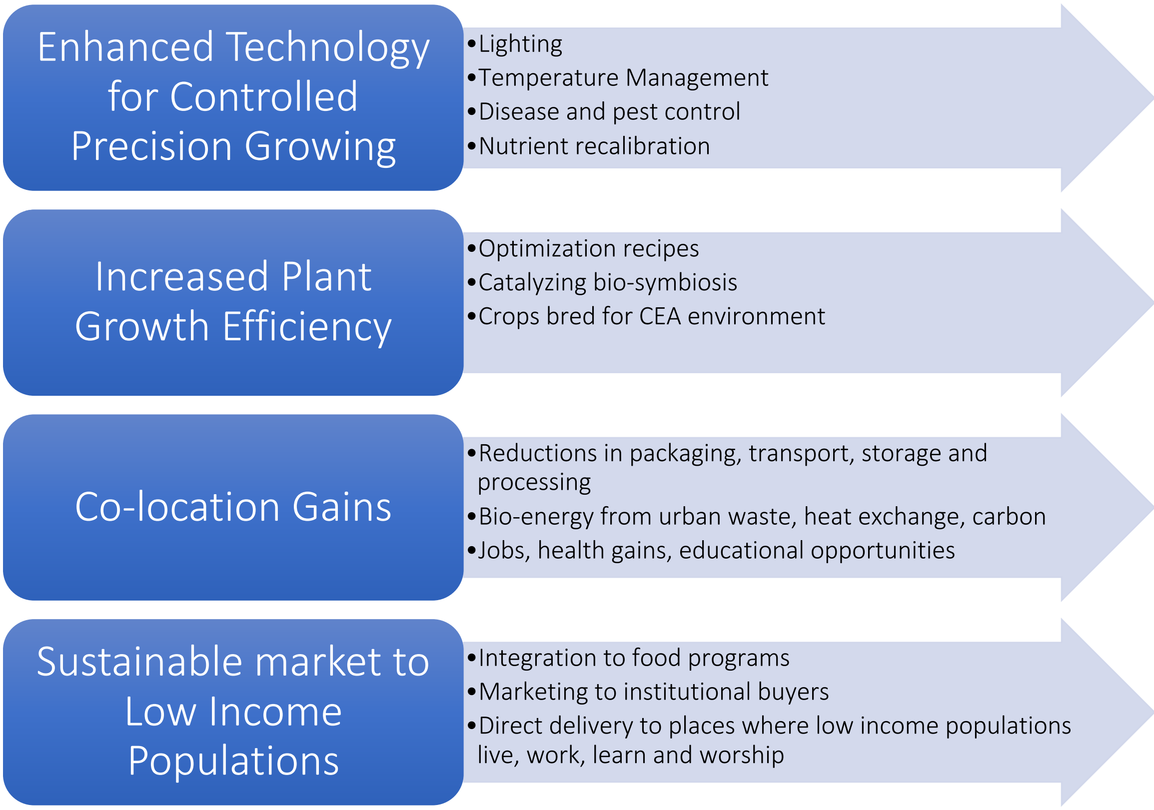
3. Could the design of new processes, as well as the development of new, or already existing technological applications, specific to your case studies, be transferred to other food systems/ challenges (consider both, food systems described in the workshop as well as new ones)? Could this transfer benefit also other socially different realities (consider also the possibility of reverse transfer)?

- Growing Systems: Until technological solutions can be brought to bear, the costs of precision agricultural growing systems make them inappropriate for use within the context of the developing world scenarios which many of the other case studies were located. That said, hydroponic growing systems being used without other aspects of controlled environment growing (without the control of lighting, temperature, humidity and other environmental conditions) are being used creatively within a number of developing world contexts. For example growing feed for cattle in Kerala, India; and vegetables for human consumption in rooftop gardens in Cairo.

- Distribution: The problem of food deserts and getting food to low income populations in urban areas is one which precision urban agriculture can only play a small role in solving. The model being proposed of leveraging existing public programs and systems both as direct consumers of healthy produce and as delivery and engagement points to reach low income consumers could apply to a much broader range of food products.

4. Which knowledge gaps should primarily need to be addressed?

The figure below represents the key knowledge areas which we feel need to be addressed to advance the work projected within the case study.



Science & Technology
FORESIGHT
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Announcement

"SmartGrids for Urban Food Systems"

17-19 July, 2018 - Bari

WG FOOD

National Research Council of Italy

Workshop on Simulations Studies of SmartGrids for Urban Food Systems (UFS), Bari*, July 17-19*.

Current food systems (FS) are at risk primarily because they are dependent on natural resources, and these resources are currently not fully managed sustainably and efficiently [1]. In the future, their availability could be further reduced due to climate change. Moreover, a growing population, rising income, urbanization, a more aged and more educated population, as well as migration, are all factors that will put pressure on the FS and encourage dietary changes toward foods richer in animal proteins [2]. Current FS are also increasingly exposed to global instability, due to the links between climate change, extreme events, resource degradation and social, economic, and political crises [3]. Foresight studies [4] confirm that there is an urgent need to address critically the shortcomings of the present agri-food sector and that substantial changes throughout the whole system will be required.

As a result of two workshops organized by the CNR Foresight Group, international experts proposed, the development of a **SmartGrid for food systems**. The grid would be based on the criteria of sustainability and health and would connect different FSs in a dynamic way. The SmartGrid, generated through the application of existing and emerging technologies as well as innovative processes, would allow the exchange of information and knowledge, supporting a system that matches needs (not necessarily demand) and production, while optimizing the use of resources and allowing for sustainable compensation of goods among FSs.

SmartGrid Criteria:

- **Match** supply and variety to needs (nutritional needs, social needs, economical needs)
- **Optimize** use of resources (soil, water, energy, genetic resources, human resources) in terms of efficiency and sustainability
- **Balance** sustainable production and needs through sustainable movements of goods among different FS ("over"production in one FS is used to **compensate** deficiencies in another one)
- **Support** agricultural ecosystems and ecosystem services

SmartGrid Functions:

- monitor and evaluate local and regional key supply chain data;
- connect capacities and needs through distribution networks at various levels;
- integrate different agri-food value chains within the FSs connecting them to each other
- monitor, and eventually predict response to future climatic, environmental and socioeconomic conditions, and respectively connect different FS in order to dynamically respond to needs
- adapt production processes and technologies to resources.

SmartGrid Characteristics:

- Two-way communication
- Smart/Responsive
- Accessibility of old data; collection of new data; integration of food chains data into FSs

1) *Simulation studies on UFS*

For the scope of the meeting we will limit ourselves to a **case study simulation,** acquiring **key indicators** on the UFSs (see suggested list below). A SWOT analysis based on the key indicators, consideration of UFS's characteristics and challenges, as well as adherence to the SmartGrid criteria, will support researchers in identifying intervention points and propose actions, tools, and research priorities.

2) *Why UFS?*

According to the UN "World Urbanization Prospects" (2014), by 2050 approximately 66% of the population will be leaving in urban areas, and while there are great differences in patterns of urbanization, all major areas will be urbanized: Africa 56,0%; Asia 64,4%; Europe 82,2%; Latin America and the Caribbean 86,0%; Northern America 87,3%; Oceania 74,0% [5]. Already by 2030 more than one in four people worldwide will live in a city with more than 1 million inhabitants, even though less then 9% will reside in mega cities (more than 10 million inhabitants). The overwhelming majority of the world's cities, have fewer than 5 million inhabitants; here resides 43,5 % of the world's population. It is also interesting to note that most of the world's fastest growing cities are located in Asia and Africa [6]. Urban food markets already consume up to 70% of the food supply [7] and cities consume over 75% of the world's resource**,** while only 3% of the earth's land surface is occupied by urban areas [8].

3) *Which are the challenges and characteristics of an UFS?*

All UFS, whether related to mega cities or small cities, face development, governance and sustainability challenges.

In particular we should consider the following **challenges**:

- The **use of resources**.
- **Growing inequalities** in wealth, health, access to resources, and availability and affordability of services connected to food security.
- **Environmental pollution**, one of the most serious consequences of urbanization.
- Social and physical impact on the global environment of **food provisioning** in the cities [9].
- **Rationalization** of the nutritional and health value of foods and their consumption in an urban system
- **Mitigation** of the impact of rare detrimental events in urban food supply system (flooding, new pathogens, etc.)

The **specific characteristics of a UFS** influence how we address the challenges:

- **Nutrition transition** → *Availability and Accessibility* of nutritious and diverse food
- **Food deserts** → *Accessibility*
- **Hybrid food provisioning system** → urban and peri-urban dynamics but also dynamics at a distance - regional, national, global
- **Diversities** → Cultural *Apropriateness*
- **Urban agriculture** → development within the UFS

4) *How can a SmartGrid help?*

- **Support identification of needs** (nutritional, economic, environmental) and **connect them to the available resources** in order to optimize their use.

- **Connect different flows** allowing not only resources and needs to be connected, but also considering (city)waste as a resource and recovering it as added value.
- **Connect rural areas and urban markets** to support full participation of small-scale producers in responding to the cities' demand.
- **Support organization and communication** among urban agriculture activities, which are generally characterized by low level organization
- Connect all actors and **support the creation of urban hubs and agro-clusters** to address common challenges.
- **Provide access to knowledge and information** in order to support adoption of innovation, which can enhance productivity and incomes also for local/small scale farmers.
- **Overcome the current dichotomy** between rural and urban realities (including policies) through a bridge built on communication and knowledge sharing.

5) ***At which level could technological innovation bring benefits?***

- **Innovation can support better use of resources:** energy, water, soil
- **Connect flows:** decentralized low-tech systems to connect flows of consumption (needs) and production (resources).
- **Health:** create tools to collect data about nutritional needs and dietary needs. *Make this information available to producers.*
- **Food production:** create tools to collect data about resources (soil, water, biodiversity etc.) and able to correlate them with the nutritional/dietary needs of the urban population. (→ **Health**) *Create tools to inform the consumers about the local production*. Provide support to farmers.
- **Food Processing:** An UFS should take advantage of the proximity of production to consumption sites and provide fresh and nutritious food to the urban population. These products are mainly perishable products. Innovative processing methods, or adapted traditional ones, that can enhance the nutritional quality avoiding waste, while taking advantage of this proximity should be prioritized.
- **Distribution/Storage:** Peri-urban and urban food producers can reach consumers through innovative (short) distribution tools and chains.
- **Consumption:** In UFS diet-related ill-health has proven to be one of the main drivers for change.
- **Connection**: Connect consumers and producers, creating a bidirectional communication grid. Create adequate tools that support a knowledge-based decision-making process: nutritional needs and a diverse diet should be the drivers for production and not simply consumers demand.
- **Wastes:** Use of urban resources is a characteristic of UFS.
- **Resilience:** Producing more around the cities can enhance resilience creating less dependence from more distant, global supply. Urban agriculture also helps mitigate the impact of climate change. Support local biodiversity.

6) Planning process for the simulation

City region level. We decided to consider the city and its peri-urban surroundings.
In particular, in Italy we chose the **metropolitan city of BARI**, covering an area of 3825 km^2 and including 41 municipalities. As for the African studies **ACCRA (Ghana)** and **DAKAR (Senegal)** are being considered by GG.

The participation of local actors will facilitate the collection of the key indicators and help us better define the focus.

[1]www.unep.org/resourcepanel/KnowledgeResources/AssessmentAreasReports/Food/tabid/133335/Default.aspx
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AGENDA

Topic: SmartGrid for Urban/Peri-Urban Food Systems: How Innovation can Address Food Security, Food Safety, Sustainability and Nutrition.

Location: Bari, Italy
Dates: July 17-19, 2018

Tuesday July 17 ***Città Metropolitana*****,** ***Sala Giunta,*** *Lungomare Nazario Sauro, 29*

14:30 – 14:35 Welcome, Antonio Logrieco, CNR, Director of the Institute of Sciences of Food Production
14:35 – 14:40 Welcome, Antonio Stragapede, Counselor "Città Metropolitana", Bari – Agricolture-Sector

14:40 – 14:55 What is a SmartGrid?

14:55 – 15:10 1st Case Study BARI: Introduction by Vitandrea Marzano, Food Policy - Mayor's Staff, Bari
Case study presentation, CNR
15:10 – 15:20 Q&A
15:20 – 15:40 2nd Case study (Presentation GG), Q&A
15:40 – 16:00 3rd Case study (Heifer Int.), Q&A
16:00 – 16:20 4th Case study (IDE), Q&A

16:20 – 16:45 Coffee Break

16:45 – 18:00 *tbc*:
Nutrition
*Blockchain, IoT (*Clara Bacciu)
Data Banks, Monitoring Systems (Valeria Ancona)
SCPS Interconnecting technologies (Manlio Bacco)
Signal processing, image understanding, artificial vision (Sara Colantonio)
Modelling, computing systems (Agrometereology/Climate) (Massimiliano Pasqui)
Processing/Precision agriculture (Francesco Montesano)
Food Digital Identity/ValueGo (Francesco Marandino, Luciano Magliulo)

18:00 – 19:00 Discussion: Are there common denominators (challenges/priorities) in the 5 case studies presented? Could the connections provided by a SG help address those challenges? Which technologies/processes could best support the SG development in the UFSs presented?

Wednesday July 18 ***Field Day***

- 8:00 – 9:00 Bus Transfer **Bari – Noci**
- 9:00 – 10:30: **Azienda Deliziosa** (Local cheese and dairy products factory)
- 10:30 – 11:30 Bus Transfer **Noci - Fasano**

- 11:30 – 12:45: **Cooperativa Progresso Agricolo, Fasano** (vegetable and fruits production for export)

- 13:00 14:45 **Lunch break**

- 15:00 – 16:30 **Centro Ortofrutticolo Mediterraneo** (local vegetable and fruit distribution market)
- 16:30 – 17:00 Bus Transfer **Fasano** - **Monopoli**
- 17:00 – 18:00: **Azienda La Pietra** (horticultural production with a high technological level)
- 19:00 Bus transfer to **Bari**

Thursday July 19 ***CNR, Area della Ricerca di Bari,*** *Via Giovanni Amendola 118*

9:00 – 9:15 **FAO:** How can policy makers support SGs for UFSs
9:15 – 9:30 **Bioversity:** Synergy with other current projects and initiatives on UFSs

9:30 – 11:00 Discussion
- Identify up to two priorities to focus on in the project proposal (e.g. food safety, nutrition)
- Can the strength of one UFS be used to address criticalities in other UFSs (e.g. Biodiversity and Mediterranean Diet)? Can successful technologies/processes be transferred? (e.g blockchains' use for traceability; Informal markets for better inclusion of women…)

11:00 – 11:20 Coffee Break

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- Breakdown in 2 discussion groups (e.g. food safety and nutrition) with the technical experts, that potentially best address that specific challenge: Which are the project's objectives? Which actions, work packages can we propose? Which are the expected impacts?

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14:15 – 14:45 Report from the 2 groups. Is integration possible?
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16:45 – 17:00 Way forward and conclusions

"SmartGrid for UFS" , Bari 17-19 July 2018
Partecipants' List

CNR:

Foresight Group:	Cecilia Bartolucci
ISPA, Institute of Sciences of Food Production (Bari): Mycotoxins, Food Safety, Aquaponic	Antonio Logrieco, (director) Francesco Montesano, Francesco Serio, Angelo Parente
IRSA, Water Research Institute (Bari): Water/Soil management	Valeria Ancona,
IIT, Institute of Informatics and Telematics (Pisa): Blockchain, IoT, Data Platforms	Clara Bacciu
ISTI, Institute of Information Science and Technology, (Pisa): Signal processing, image understanding, artificial vision	Sara Colantonio
SCPS Interconnecting technologies	Manlio Bacco
IBIMET, Institute of Biometeorology (Rome): Climate change analysis, impacts on agriculture	Massimiliano Pasqui
Global Good Fund: Flavotoxins for feed, Food safety	Marie Connett, Megan Bettilyon
Heifer Uganda	William Matovu,
IDE:	Abigail Nydam
FAO: Policy	Fatima Hachem
Bioversity: Agrobiodiversity, nutrition landscapes, urban-rural connections	James Garrett
Penelope SpA: FDI/ValueGo	Francesco Marandino, Luciano Magliulo
City of Bari: Counselor "Città Metropolitana", Bari-Agricolture-Sector Food Policy - Mayor's Staff,	Antonio Stragapede, Vitandrea Marzano
University of Liverpool: Management School	Jorge Hernandez

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Food Policy - Mayor's Staff,	Vitandrea Marzano
University of Liverpool: Management School	Jorge Hernandez

Presentations

SmartGrid for Urban/Peri-Urban Food Systems: a simulation analysis for the Metropolitan City of Bari (Italy)
Francesco. F. Montesano, Francesco Serio, Antonio Parente, Antonio Logrieco
Institute of Sciences of Food Production, National Research Council of Italy, Bari
Valeria Ancona,
Water Research Institute, National Research Council of Italy, Bari

Analysis of Peri-Urban Oilseed-to-Dairy-Feed-to-Milk Value Chains: Focus on Punjab, India with some Kenya/Uganda/Ethiopia observations
Learnings and potential opportunities -- following the path from source crops to end products
Marie Connett, Parvati Patil
Global Development Technologies Portfolio, Global Good Fund, Intellectual Ventures, Seattle, USA

The availability and distribution of fruits and vegetables, in view of the challenges of increasing urbanization in low-resource settings
William Matovu
Heifer International, Uganda

From the Farmer Point of View: Productivity and Risk in Ghana
Abigail Nydam
IDE

Blockchain Technology and IoT
Clara Bacciu
Institute of Informatics and Telematics, National Research Council of Italy, Pisa

ICT Perspective in a SmartGrid for Urban Food Systems
Sara Colantonio, Manlio Bacco
Institute of Information Science and Technology National Research Council of Italy, Pisa

Technologies to increase trust in the supply chain
Francesco Marandino, Luciano Magliulo
Penelope SpA, Napoli, Italy

SAFA, Sustainability Assessment of Food and Agriculture Systems
Fatima Hachem
FAO, Rome, Italy

Nutrition and SDGs
James Garrett,
Bioversity, Rome, Italy

SmartGrid for Urban Food Systems

by Cecilia Bartolucci

Current food systems (FS) are at risk primarily because they are dependent on natural resources, and these resources are currently not fully managed sustainably and efficiently. **Urban Food Systems** (UFS) represent a particularly important challenge since, according to the UN "World Urbanization Prospects" (2014), by 2050 approximately 66% of the population will be living in urban areas. There is however a spiral that connects urbanization with poverty and unhealthy diets, showing in particular in the triple burden of malnutrition (undernutrition/overnutrition and micronutrients deficiency) as well as in diet-related diseases.

Rising urban demand for more and better food provides new opportunities for improving farmers' livelihood, support diverse food production, and address urban poor and vulnerable populations. Encouraging stronger rural-urban linkages, would support more efficient, sustainable and inclusive food systems, and would allow to overcome the current dichotomy between rural and urban realities.

The development of a **SmartGrid for food systems** based on the criteria of sustainability and health, which potentially connects in a dynamic way different value chains and all actors within the UFS could provide a new, disruptive approach that addresses the main challenges. The idea of a SmartGrid for FS was developed by a group of international experts during two workshops organized by the Foresight Group of the National Research Council of Italy [*www.foresight.cnr.it*]. The SmartGrid, generated through the application of existing and emerging technologies as well as innovative processes, would allow the exchange of information and knowledge, supporting a system that matches needs and production (not necessarily demand and supply), while optimizing the use of resources and allowing for sustainable compensation of goods among FSs.

Innovative within the SmartGrid approach are not the single technologies used to make single sectors or single value chains more sustainable, nor technologies to make the food healthier or the distribution more equitable; innovative and disruptive is the approach that recognizes that the principles on which the SmartGrid is based are inextricably interlinked. These connections, while considerably adding to the level of complexity, reflect a real system approach, and move away from a linear system, introducing dynamism, responsiveness, adaptability and resilience.

Within UFSs the SmartGRid approach can support the application of adaptable solutions for diverse, however concrete issues: promoting efficiency through defragmentation of the information; supporting technology transfer through connection and inclusion of all, even "week" actors; anticipating change, rather than reacting to it, through the integration of week signals into a network, taking into account the whole spectrum of impacts (economic, environmental, social).

SmartGrid Criteria:

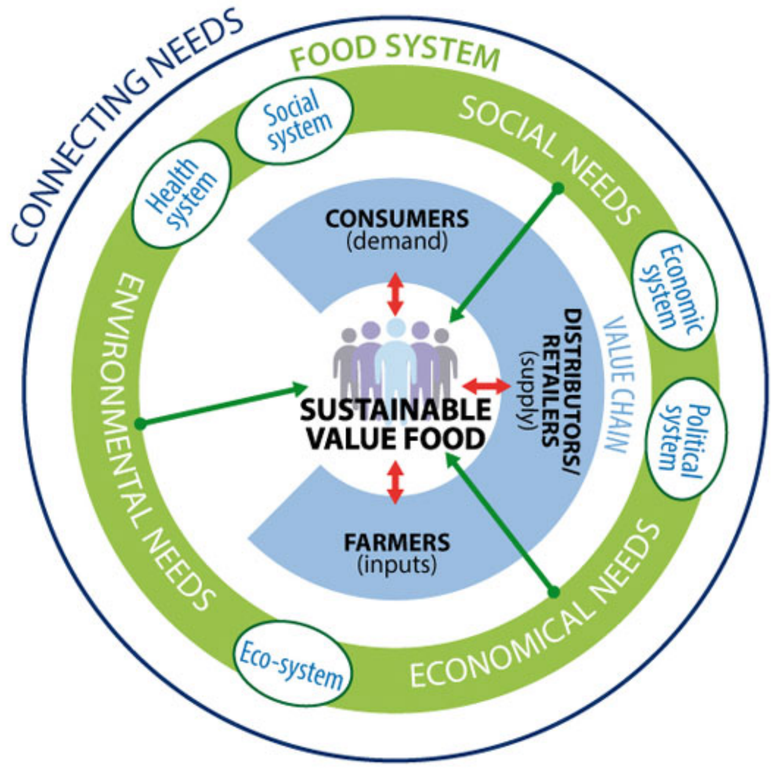
- Match supply and variety to needs (nutritional needs, social needs, economical needs)
- Optimize use of resources (soil, water, energy, genetic resources, human resources) in terms of efficiency and sustainability
- Balance sustainable production and needs through sustainable movements of goods among different FS ("over"production in one FS is used to compensate deficiencies in another one)
- Support agricultural ecosystems and ecosystem services

SmartGrid Functions within a UFS:

- Monitor and evaluate local and regional key supply chain data;
- Connect capacities and needs through distribution networks at various levels;
- Integrate different agri-food value chains within the FSs connecting them to each other
- Monitor, and eventually predict response to future climatic, environmental and socioeconomic conditions, and respectively connect different FS in order to dynamically respond to needs
- Adapt production processes and technologies to resources.

SmartGrid Characteristics:

- Two-way communication
- Smart/Responsive
- Accessibility of old data; collection of new data; integration of food chains data into FSs



SmartGrid properties:

- Main driver: the **needs** of the human beings and societies
- Engine: **social innovation** (inclusive processes co-designed by all actors involved (even the more vulnerable ones)
- Connect independent actors and resources into a coherent, collaborative, open and scalable UFS to gain **efficiencies**, **responsiveness** and scale, while providing a transparent way of allocating collaboration benefits among actors;
- Take full advantage of **local** food production/consumption nodes of any scale, including alternating node roles, i.e. micro-enterprises in rural & urban areas;
- build on existing and emerging technological infrastructure, already available along the various agri-food chains and focus mainly on integrating, enhancing and adding intelligence, instead of replicating it.