Dealing with the challenge of sustainable water resource management in food chain development

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Global demand for agricultural products is projected to rise at least 50% over the next two decades (UN Millenium Project, 2005). Irrigated agriculture provides more than 40% of world food and uses 70% of total water withdrawals (Madramootoo and Fyles, 2010). Groundwater use in irrigation is increasing both in absolute terms and in percentage of total irrigation, leading to overexploitation both in arid and in temperate areas (Siebert *et al.* 2010). Population growth, evolution of eating habits, price volatility and markets fluctuations, all contribute to reinforcing tensions over water in the agricultural sector (Jamin *et al.*, 2011). Further growth of agricultural production will have considerable implications for water use, especially groundwater.

The need to reconcile agricultural production and water conservation has prompted widespread innovation towards more sustainable farming methods but also to more sustainable food supply chains, especially through "local" or "short" supply chain (see for instance Marsden *et al.*,1999 and llbery, 2005). Sustainability is even increasingly used as a marketing argument. Several studies conducted in France (INRA, 2006), Asia and North Africa (Molle, 2011) have highlighted the interest to support the crop diversification within irrigated farms to reduce their vulnerability both to decreasing resources availability and agricultural price volatility. These researches showed that agricultural diversification strongly depends on (1) water and land availability, soil fertility and possibility of securing mid to long term access to these resources and (2) potential marketing outlets and organization of agri-food sectors. Recent studies also showed that the relationships between farmers and agri-food operators influence farmers' production choices and production patterns (Farès *et al.,* 2012) and that farmers' strategies to decreasing water resources impact on farm and agrifood sector economy (Bouarfa *et al.,* 2011; Lejars *et al.*, 2012).

However, despite this increasing interest in more sustainable food chain or diversification, few analyses have examined the role of the overall organization of food chains at local and regional level (lIbery, 2005), including food chain competition for water resources. Emphasis on food chains at a regional level is an important departure to reach sustainable management of water resources used by agriculture, because as Cobb *et al.* (1999) recognized "the food chain as a whole is the ultimate framework for a scrutiny of sustainability". Moreover, in practice, the food chains actors and their interactions are rarely part of the water management process. They are not taken into account through the traditional toolkit of instruments for managing water demand (volumetric price, intersectoral allocation water, water rights), widely understood as being part of the integrated water resources management (IWRM) paradigm. Neither are they taken into account by the state that mobilizes formal structures in its agricultural policies, such as banks or advisory services and that only targets farmers, but fails to take the whole supply chain that has been constructed around them into consideration.

The aim of this paper is to analyse how different types of stakeholders (farmers, agrifood sector operators, water resources managers, public organizations in charge of agricultural and environmental policies) interact formally (explicitly) or informally (implicitly) around the management of water in a shared territory. Based on first experiences led in two contrasted areas, in Beauce (France) and in Morocco (Sa´'is), we showed that: (i) The availability of water resources, especially groundwater, impact on farmers' strategies and practices, and indirectly on the development and organization of food supply chains, (ii) the overall organization of agriculture supply chain(s), especially through contractual relationships, directly influences strategies and practices of farmers, including in terms of use of ground-

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water resources (iii) the amount of resource available could lead to competition between food chains (iv) analyzing relationships between supply chain actors can help identify new key actors to enhance or limit the further extension of groundwater irrigation.

Access to groundwater resource and developement of food supply chains

Some major traditional cereals growing basins as Beauce in France and Saiss in Morocco have experienced during the past 30 years a broad diversification of productions associated with the development of irrigation. This development has led to the establishment of new downstream sectors in trade or processing, that play a structural role for agricultural change. The irrigation first appears in these regions, consecutively to a drought event, to secure the traditional cereals and grains crops. Endowed with this new water resource, farmers took rapidly new opportunities of crops diversification and downstream operators also invest in these new chains as the production was quickly growing. Vegetables (beans, onions, potatoes) and seeds are high value crops that are favored by farmers when they get a secured resource for irrigation. Groundwater with individual access is generally considered as a more secured resource than surface water networks which are collectively managed and subject to organizational problems.

In the Sais, central Morocco, a pioneer area for groundwater exploitation, onion production has raised 10 times since years 2000's and it is now the leading basin in the country, covering 50% of the national supply. Individual access to groundwater through a liberalization of drilling, and diffusion of drip irrigation have led to this expansion of cultivated area and yields increase. But this economic development based on unregulated groundwater withdrawals also led to an overexploitation. A drop of piezometric levels of 60 m in the last 20 years is met in some parts of the Sais aquifer. The economic stakes of this resource abstraction have, so far, impeded the search of solutions. The valorization of productions implies for 80% of products, informal distribution channels with a high number of market intermediairies (middlemen, brokers...). For the Sais onion chain, Lejars &Courilleau (2015) estimate a number of 2000 intermediaries for 4000 producers. Despite their flexibility these operators have difficulties to integrate long term sustainability issues, and to anticipate a possible collapse of the resource.

Organization of supply chains and irrigation use

A current trend in many agri-food supply chains is the qualitative segmentation of markets to meet demand requirements and get a better valorization of products. This segmentation leads to the development of contracted crops with production specification. Irrigation is often a technical component needed to ensure this specification. In Beauce, most of the new sectors developed thanks to irrigation, have based their supply on contracts: vegetables, seeds, malting barley. Satisfaction of crops water requirements for quality standard is a contractual obligation.

Traditional supply chains of the region such as cereals and sugar be*et al.*o developed quality differentiation or contractual commitment on quantitative delivery that implies an optimized level of irrigation. For the agro-food firms, the presence of a water resource available for irrigation is considered as a key factor for their investment localization strategies.

Competition between food chains for water resource

In many situations, in particular with groundwater which is subject to individual abstraction, water is a scarce resource, not sufficient to cover all the needs. Irrigating farmers have to arbitrate the water allocation between crops. Their individual decisions have aggregated impacts on the total volume of production at basin level, and finally on the supply of downstream operators. Insufficient production can lead to the closure of processing or packing units that will affect the whole supply basin. In Beauce this problem occurs after the implementation of management rules of the regional aquifer. Farmers received individuals quotas of water withdrawals, these quotas were annually adjusted before the cropping season, subject to the level of the watertable. This management system can potentially lead to severe

restriction of water access and put at risk several industries particularly dependant on irrigation: the vegetable canning industry, the malting, the sugar and the seeds industries. Downstream operators were associated in participative workshops with farmers representative and resource managers to estimate the physical and economic impacts of water restrictions for each industry (Lejars & fusilier, 2012). Some leeways to adapt supply organization (cropping calendar, norms) or water management rules (temporary exemption, permit to carry over the quota, geographic differenciation...) to potential restrictive scenarios were also discussed.

Analyzing relationships between supply chain actors can help identify new key actors to limit the further extension of groundwater irrigation

Relationships between supply chain stakeholders require analysis and intervention because they are a leeway to improve water savings. Analyzing relationships between supply chain actors can help identify new key actors to participate to water management processes. Making them visible is the first step to including them in water management, as they clearly depend on this resource. In Beauce, first experience showed that actors of food processing sectors are interested in participating in negotiations around groundwater volumetric management and should be included in the water management processes. In Morocco, first studies showed that the state should include supply chains actors in particular inputs suppliers in its agricultural policies. They could become major nodes for the dissemination of information and innovation and they not only have personal relations with farmers, but also close links with state representatives.

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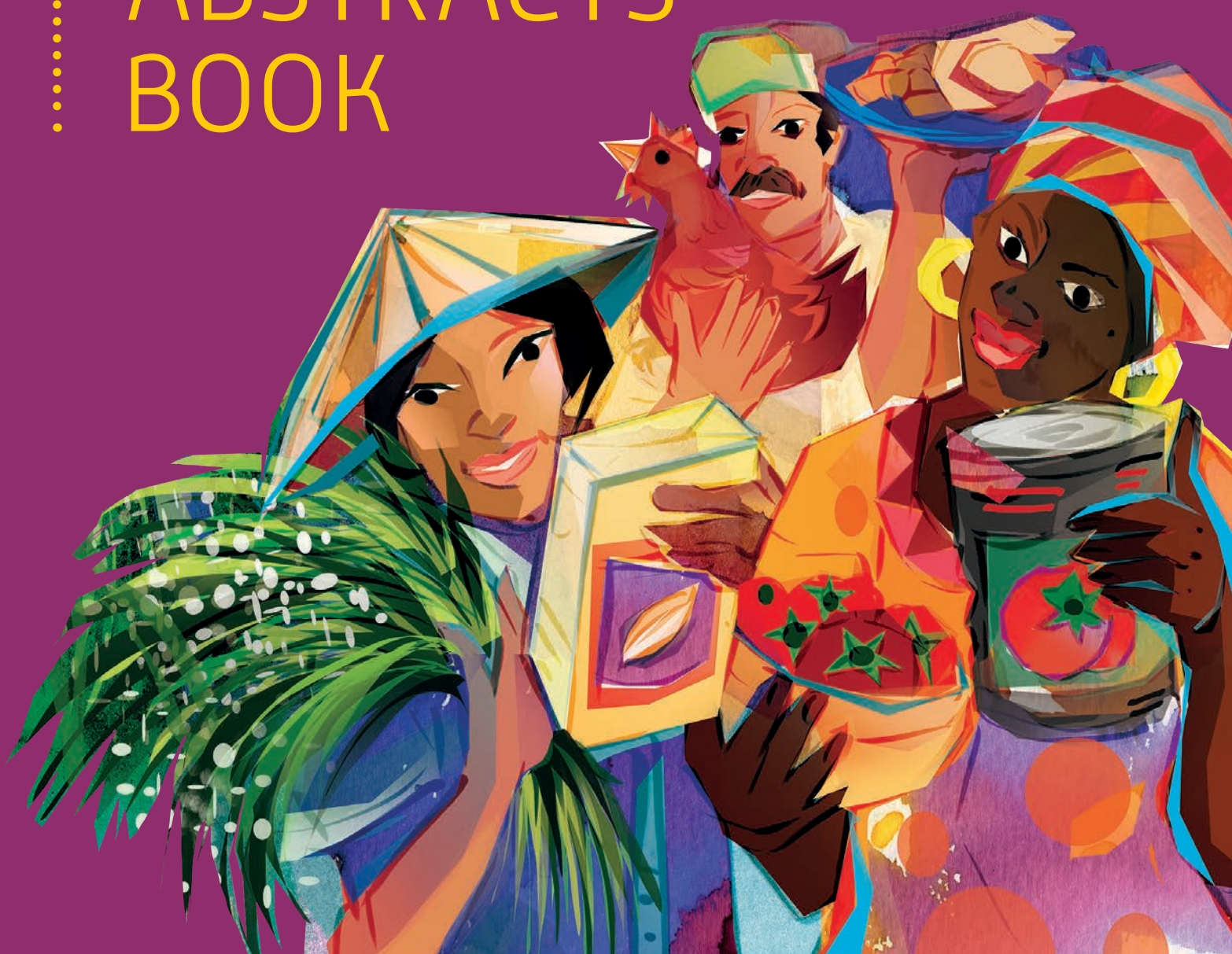

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Welcome to **AC&SD** 2016

On behalf of the Scientific and Organizing Committees, it is a great pleasure to welcome you to the International Conference on Agri-chains and Sustainable Development (**AC&SD** 2016). This conference aspires to widen the debate about the role of agricultural value chains towards sustainable development. Year 2015 was a critical political and diplomatic milestone: the member states of the United Nations signed a new agenda for development, with the 17 Sustainable Development Goals (SDGs) placing sustainability at the core of international efforts. Development and academic actors are since then exploring new avenues for translating the SDGs into reality and implementing global and local frameworks and partnerships. Our conference aims at joining these efforts, with the consideration that agricultural value chains form spaces where local and global challenges to sustainability connect and within which local and global actors experiment and negotiate innovative solutions.

The scientific committee has assembled a very attractive program for **AC&SD** 2016 that seeks to cover and confront the diversity of realities behind agri-chains, from localized chains, embedded in specific places, to global value chains. In the parallel sessions, transformations of these agri-chains and their connections to sustainable development will be discussed by speakers from the academia, the civil society, the private sector and decision makers. This multi-stakeholder perspective will also be brought about in the plenary sessions. Here, world renowned keynotes and panelists to three high level round tables will discuss about the role and importance of evaluation, public and private institutions and innovations at different scales for transforming agri-chains towards sustainability transitions.

This edition gathers about 250 participants from 39 countries. **AC&SD** 2016 owes a lot to the scientific and organizing committees for preparing the program, and particularly to Brigitte Cabantous, Chantal Carrasco and Nathalie Curiallet for all the logistics, as well as to our support team of Alpha Visa that we warmly thank for their help.

We wish us all a fascinating, successful, inspiring and enjoyable **AC&SD** 2016 and we very much look forward to its result and to the strengthening of both a scientific community and a community of practice to implement the outcome!!

Estelle Biénabe, Patrick Caron and Flavia Fabiano,
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Session 10

Innovations in approaches and tools for inclusive and efficient value chain development

Session 11

Linking global value chains and territories: conceptual insights for understanding and ensuring sustainability at different scales