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in

Petruzzella D. (ed.), Di Mambro A. (ed.).
Innovation in the Mediterranean agrifood Sector. Concepts, experiences and actors in a developing ecosystem

Bari : CIHEAM
Options Méditerranéennes : Série B. Etudes et Recherches; n. 74

2016
pages 9-17

Specificities of agriculture, innovation and development in the Mediterranean region

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Abstract. Mediterranean agriculture and food production now have to face the great challenges of ensuring sufficient healthy and nutritious food to feed the population. Overcoming these challenges requires a great effort to transfer knowledge and accelerate innovation. The Mediterranean is a kind of microcosm representing many of the current challenges to agrifood production and consumption models. Some of these are particularly urgent: declining biodiversity, climate change, the shift towards new and not always sustainable food consumption habits, dependence on supplies, are all unknown factors that may be revealed and managed only with a strong input of technological and organisational innovation. Although the specificities of agriculture mean that models imported from other sectors cannot function, it would be a mistake to refuse the opportunity of networking with players outside the traditional innovation ecosystem. Farming involves dealing with many unprecedented risks because, in addition to the traditional risk posed by the climate, there are now also political and market variables. The agricultural innovation ecosystem should begin to reorganise itself from within, seizing the opportunity offered by a phase of transition towards open innovation models.

Keywords. Risk management – Mediterranean – Food security – Local and global – Climate change – ICTs.

Spécificités de l'agriculture, innovation et développement en Mediterranee

Résumé. *En Méditerranée, l'agriculture et la production alimentaire doivent répondre à des défis importants pour garantir à la population une nourriture suffisante, saine et nutritive. A cette fin, il est nécessaire d'intensifier les efforts visant le transfert de la connaissance et l'accélération de l'innovation. La région méditerranéenne forme un véritable microcosme qui reflète en grande partie les défis encore ouverts autour des modèles de production et de consommation agroalimentaire. En particulier, l'érosion de la biodiversité, le changement climatique, la transition vers de nouvelles habitudes de consommation alimentaire pas toujours durables, la dépendance des approvisionnements sont des enjeux majeurs mais méconnus, qui peuvent être appréhendés et abordés seulement à travers une forte innovation sur le plan technologique et de l'organisation. Si, en raison des spécificités de l'agriculture, l'importation de modèles issus d'autres secteurs ne peut pas réussir, refuser la mise en réseau avec des acteurs en dehors du cadre traditionnel des écosystèmes de l'innovation agricole serait néanmoins une erreur. Parce que pratiquer l'agriculture signifie prendre des risques, le plus souvent inédits, d'autant plus que des variables liées à la politique et au marché s'ajoutent au risque climatique traditionnel. L'écosystème de l'innovation agricole devrait entreprendre une réorganisation interne, en saisissant l'opportunité d'une transition vers des modèles d'innovation ouverte.*

Mots-clés. *Gestion des risques – Méditerranée – Sécurité alimentaire – Local et global – Changement climatique – TIC.*

I – Old certainties and new risks

Farming is a risky enterprise from an economic point of view.

This is mainly due to the close relationship between farming activities and life cycles, growing seasons, weather conditions and the ways in which they interact with the climate and the quantity and quality of the main asset: the land. The key factors affecting farming production worldwide are the surface area for agricultural use and the soil type, along with climate conditions and water availability.

The relation between agriculture and ecosystems significantly affects the nature of the enterprise, because managing a farm business is not the same as managing a factory that makes bolts or ball bearings. After all, the fact that in many languages the equivalent of the Italian word “impresa” (enterprise) is seldom used when speaking of farming says a lot about the peculiarities of this sector. *Exploitation agricole* in French, *farm* in English, *granja* in Spanish and *Bauernhof* in German. In Italy, where farms are *businesses,* the “‘*imprenditore agricolo*” is a professional farm entrepreneur (*IAP),* whose activity is covered by specific laws recognizing the special features of business risk in the primary sector.

The land is a capital (the land capital) which requires appropriate management techniques. The predominance of biological factors and the management of production assets that mostly include living matter (plants and animals) imply, in general, a high incidence of fixed costs on productions costs and a certain degree of supply rigidity. Dairy cows do not have a tap that we can just turn off and on at will, and trees do not bear fruit on request. Products spoil and hence, proper solutions are needed for post-harvest handling, transport and storage. Therefore, farm businesses adapt more slowly to market signals compared to businesses in other sectors.

Even the timing of cash inflow and outflow, meaning the financial resources used for production and revenues, has its peculiarities. Farmers buy seeds, use machines and employ labour in a given period of the year, and if all goes well, they will earn money after a few months. It may be difficult to predict accurately the yield and quality of harvest or production. Climate and weather are a source of additional uncertainty and increase the investment risks. In agriculture, “breaking down” the production activity is harder than in other sectors.

Farming systems are the outcome of different combinations of markets, ecosystems, land, labour, capitals and other inputs. But they are also made up of interwoven identities, social behaviours and cultures. They are closely related to the local context and territory, which means not only an area characterised by specific bio-physical features but also a social space embracing consumption, production and trade models. Different farming systems can coexist within the same territory, quite near to each other. Life cycles, territories, historical and social factors also affect farming organization.

In the Mediterranean region, the natural and social environments have led to the establishment of farms that are generally family owned, with a certain level of fragmentation of the productive fabric and an endemic difficulty of integration into other realities, even within the same territory. Various forms of cooperation in the region may constitute an exception, but in general we may say that in the countries around the Mediterranean Sea the achievement of economies of scale in agriculture is limited by the sector’s specificities.

Farming not only means an enterprise with its own levels and types of risk, but is also a fairly sophisticated activity in management terms. Today even more than before, a farmer should be knowledgeable about biology, ecology, legislation, veterinary and medicine, economics, marketing, finance and even about trade policies, and should master at least one foreign language, namely English.

The specificities of farming activities affect the implementation, development and dissemination of sector innovation. Without this awareness, there is a risk of not going far. The experience of Calgene, regarded in the 1990s as a kind of Apple in the field of biotechnologies, teaches us a lesson. The small Californian firm, with audacious ideas and a creative team, has been a David versus the Monsanto Goliath, seen by many as the Microsoft of biotech, with an analogy drawn between seeds and software and between the intellectual property policies of the Saint Louis based multinational and those of the company created by Bill Gates. The story is told in great detail by Daniel Charles in his *Lords of the Harvest* (2001). With a very different marketing strategy from that of its rival, based on transparency of experimental data, public debate, and a continual attempt at open exchange with the opponents of agricultural biotechnology, Calgene intended “merely” to revolutionise agriculture by marketing the Flavr Savr tomato, which was

genetically engineered to lengthen its ripening period. However, it had reckoned without... agriculture. And also without weather conditions and weeds, pest attacks, the need to graft the revolutionary gene into several varieties, the long time-scale required by traditional breeding, storage, logistics and transport technology. While the millions of dollars invested by Calgene in Flavr Savr failed to generate the expected results, a tomato with similar characteristics, grown by Mexican farmers, entered the American market. It had been obtained by traditional breeding techniques and patented in the 1980s by the Israeli Nahum Kedar. The tomato's name was LSL, an acronym for Long Shelf Life, and it shattered the dreams of glory of Calgene, which was then swallowed up by Monsanto in two distinct phases, in 1996 and in 1997.

Stories like this demonstrate the distance between this sector and the innovation model developed in other contexts. When we say "start-up" in agriculture, especially if we mean a business involved in strictly primary production, we cannot refer to the Silicon Valley pattern, where the main goal of an innovative start-up is to grow big enough and fast enough to aim at being listed on the stock exchange within five years or else to die in the same period of time, and then be absorbed by larger companies. An innovative start-up in agriculture must consider that it has to come into existence to live a long life. As long as possible.

In contrast, the innovation economy model, which has characterised the Web 2.0 boom, is clearly mirrored by the development of businesses specialising in technologies related to farming activities that, above all in the US, are mobilising private resources in the form of venture capital. From 2010 to 2015, investments in "AgTech" and "FoodTech" have increased from less than 500 million to more than 4 billion dollars per year (Rabobank, 2015).

The specificities of farming, combined with its function of fulfilling the population's primary needs, provide the historical justification for public intervention in this sector, which has shaped the innovation systems traditionally characterised by a strong presence of the State. All over the world, despite some differences in scope and a few exceptions (Australia and New Zealand), agricultural policies are typically intended to support the viability of farms, by reducing entrepreneurial risk, developing regulatory frameworks, and laying down specific measures to protect the sector, including innovation systems. For this reason, the agrifood industry is by definition considered to be an economically stable sector.

Nevertheless, in the globalized world there are a number of risk factors which may not be strictly economic. Like border closure. When Russia closed its borders in 2014 to European agrifood products in retaliation for sanctions imposed by the EU and the US over Ukraine, European businesses were denied an important outlet. From one day to the next, and for reasons unconnected with the weather or economic conditions. Disturbances in the normal activity of agricultural markets can also be caused by health problems. In 2011, during a dramatic health crisis brought about by the propagation of a killer strain of *Escherichia coli,* the spread of inaccurate news about the source of infection caused the fruit and vegetable market across Europe to collapse in just a few days.

In this context, climate risk is a source of additional uncertainty, given the increased frequency of extreme weather and the rise in global average temperature. Agriculture is already paying a hefty price for climate change in terms of water availability (drought *versus* floods), soil quality, the spread of new pest species and plant diseases, modification of growing cycles, huge yield variations and impact on agroecosystems in general.

As we will see later in more detail, agriculture is today at the intersection point of an increasingly complex social demand, which coincides with an increasingly broader and overarching concept of food quality and an expansion of supply to a number of sectors like energy and biomaterials, besides the usual supply of food and feeds with a high health standard.

Faced with an increasingly stratified demand and with new risks related to climate conditions, geopolitical situations and information management in the case of health and veterinary

emergencies, traditional agricultural policies designed to support the development of markets impervious to external tensions demonstrate many limits. At least in Europe, a thorough overhaul of the sector policy has begun, not only to enhance crisis management measures, but also to promote innovation.

Despite the peculiarities of agriculture as an economic sector, the facts demonstrate that it no longer makes any sense to use this as a defensive position. Redefining relationships with the farmers and the other players of the chain (in both production and innovation), interconnecting, exchanging and "networking" with players outside the traditional agricultural innovation system now appears to be the only choice, given that the business challenges and risks are no longer those strictly confined to agriculture.

The reduction of transaction and management costs, made possible by the use of ICTs (Shirky, 2008), is a big opportunity for strengthening the integration of farms in the local area and in the global village, for increasing trade and exchange with other productive sectors and with consumers, thus paving the way for new solutions to everyday problems. That is to say, for generating innovation.

At present, agriculture is living through a paradox: the advent of the service economy has led, particularly in the Northern Hemisphere, to the perception of agriculture as a "traditional" and "natural" activity, although for thousands of years it has been the most significant of all man's actions to modify "nature", to the point that it even incubated the industrial revolution.

Apples or peaches, or even the livestock we know today, seem to be "natural". But they are man-made, the culmination of tens of thousands of years of human innovation in trade and cultural exchanges, in species selection, production of food and feedstuffs, cultural practices and storage and transport technology (Ashton, 2015).

Through the centuries, the Mediterranean has been the chosen place bringing all these connections and fusions together. The Mediterranean diet is the result: a tradition which is actually a series of very successful innovations.

II – The world and *Mare nostrum*

Due to its primary function of producing food and its close relationship with ecosystems, farming takes centre stage in the challenges facing humanity nowadays. According to FAO estimates (2012), in order to meet the demand of a burgeoning world population, with an increasing per capita income, above all in emerging and developing countries, in 2050 the global agricultural production will rise by 60% compared to the period 2005/07. This means being confronted with some constraints like the scarcity of natural resources i.e. land and water, which are essential for food production, and the impact of climate change, requiring adaptation to new conditions and shared efforts with other economic sectors to mitigate the effect of the expected rise in global average temperatures.

The change in food consumption patterns has demonstrated that complementarities exist between nutrition quality and access to food, generally measured as calorie intake. The Food Security challenge has become greater, and besides working to reduce the number of undernourished people, approximately 800 million today, this also entails fighting the nutrient deficit that affects over 2 billion people, and facing issues like obesity, traditionally a problem of wealthy countries but now increasing in developing countries (IFPRI, 2014).

The extreme volatility of the main agricultural raw material prices between 2007 and 2012, and the historically associated social unrest that broke out in 2008 and in 2010, drew attention to the primary role that food supply stability plays in ensuring social stability in general.

In short, agriculture is a nexus, a node, a critical activity expressing the interdependence of only ostensibly separate domains: water, energy, food, land, ecosystems and their social use, all contribute to the "meta-challenge" of ensuring enough healthy and nutritious food for mankind, in a sustainable way.

The Mediterranean area as a whole – the southern and south-eastern EU Members and the MENA region (Middle East and North Africa) – is a place where all these challenges are particularly prominent. Access to food and the related social issues, the food trade balance, management of ecosystem resources, food safety and nutritional quality, climate change mitigation and adaptation, maintenance of biodiversity levels: the Mediterranean area reflects, as in a microcosm, all the unsolved questions of global development.

As regards the sustainable management of resources, the Mediterranean is one of the "hot-spots" of the world's biodiversity. At the crossroads of the Euro-Asian continental block and African block, it features a vast array of geographical and topographical environments and is home to 10% of the endemic plants on only 1.6% of the world surface area (Médail and Meyers, 2004). This biodiversity is threatened by urbanisation and inefficient use of land and water.

According to the estimates of the United Nations' Intergovernmental Panel on Climate Change (IPCC, 2007), the effects of climate change on the region will be very strong. The last simulations (Gualdi *et al.*, 2013) of the Euro-Mediterranean Centre for Climate Change (CMCC) for the period 1951-2050, demonstrate that in this area, already particularly vulnerable to stress, the climate will tend to become drier and warmer, which means lower rainfall (-5%), higher temperatures (+1.5°-2°C) and a rising sea level (+7-12 cm). These conditions are very likely to affect water availability and crop productivity, soil degradation and the increasing demand for water in agriculture, levels of biodiversity and the spread of new pests and plant diseases.

The Mediterranean region is also going through a "nutritional transition" (CIHEAM, FAO 2015), where under-nutrition coexists with overweight, obesity and diet-related chronic diseases like diabetes.

The geopolitical earthquake known as the "Arab Spring" has demonstrated once more how food supply disruption may create social conflict with unpredictable results. In North African countries, the high level of food insecurity caused by the world markets' "hyper-dependence" (Abis, 2015) on the supply of staple foods such as wheat, has created an explosive mix with persistent components like social inequality and the "youth bulge": millions of people under the age of thirty, with a high level of education and poor job prospects– according to the International Labour Organization (ILO) unemployed young people in the Mediterranean coastal countries account on average for 30% of the total labour force – and the wish to extend the scope of individual freedoms.

Instability caused by the Arab Spring uprisings, combined with other geopolitical factors, has driven some countries like Libya into a condition of permanent crisis, and others such as Syria and Iraq into a conflict on an unprecedented scale, which does not show signs of ending soon and poses the threat of global destabilisation. The destruction of physical and social infrastructure exacerbates disparities, health risks, food insecurity and the degradation of natural resources, thus encouraging massive migration flows. Based on data from the International Organisation for Migration (IOM), in 2015 alone, approximately one million people have entered Europe by land and sea through Spain, Greece and Italy.

The recovery of agrifood production enabling a harmonious social, economic and environmental development and the revitalization of food consumption patterns like the Mediterranean Diet will be valuable assets once the Mediterranean trouble spots are stabilised.

Given its close links with life cycles, agriculture could be a permanent research and innovation laboratory for improving the relationship between man and the natural environment (De Castro, 2015), and this would be especially true for the Mediterranean. The creation and launch of open

knowledge and innovation exchange and sharing systems could become a driving force in this sense, at least in two ways. Firstly, in the "Mediterranean laboratory" food and agriculture are particularly important in terms of social identity and the economy; secondly, because innovation policies are now an integral part of cooperation and development policies.

III – Innovation for development

Innovation-driven economic growth is not, or at least is no longer, the prerogative of developed countries. China, India, Malaysia, Vietnam, Kenya and Uganda are examples of medium or low income economies where the creation of innovation systems is a major development driver. Agriculture and food production play a pivotal role in most of these countries.

The National science, technology and innovation plan launched in Uganda in 2012 emphasises the need for a multi-sectoral approach to innovation across all sectors of the national economy, including agriculture, energy, services and information technologies. Ghana has introduced the Farmer Field Fora, an approach to agricultural extension, using the participation of farmers and players of the food chain and of other economic sectors to increase crop efficiency and quality. In Kenya, the city of Konza is about to become a hub for the development of innovative technologies and start-up incubation in a number of sectors ranging from agriculture to mobile banking and ICTs (Global Innovation Index, 2015). In China, food security is a major concern; ensuring enough food to the population has been high on the national development agenda for decades, and the country's main agriculture universities now lead the world in patenting many of the new agricultural technologies (see Figure 1).

After a decade of stagnation during the 1990s, public investments in research and innovation in agriculture between 2000 and 2008 increased by 22% worldwide. The average annual growth rate is 2.4%, and this is mainly due to the efforts of emerging economies, with China, India and Brazil in the forefront. In contrast, investments are at a standstill or in decline in the developed countries (IFPRI, 2012).

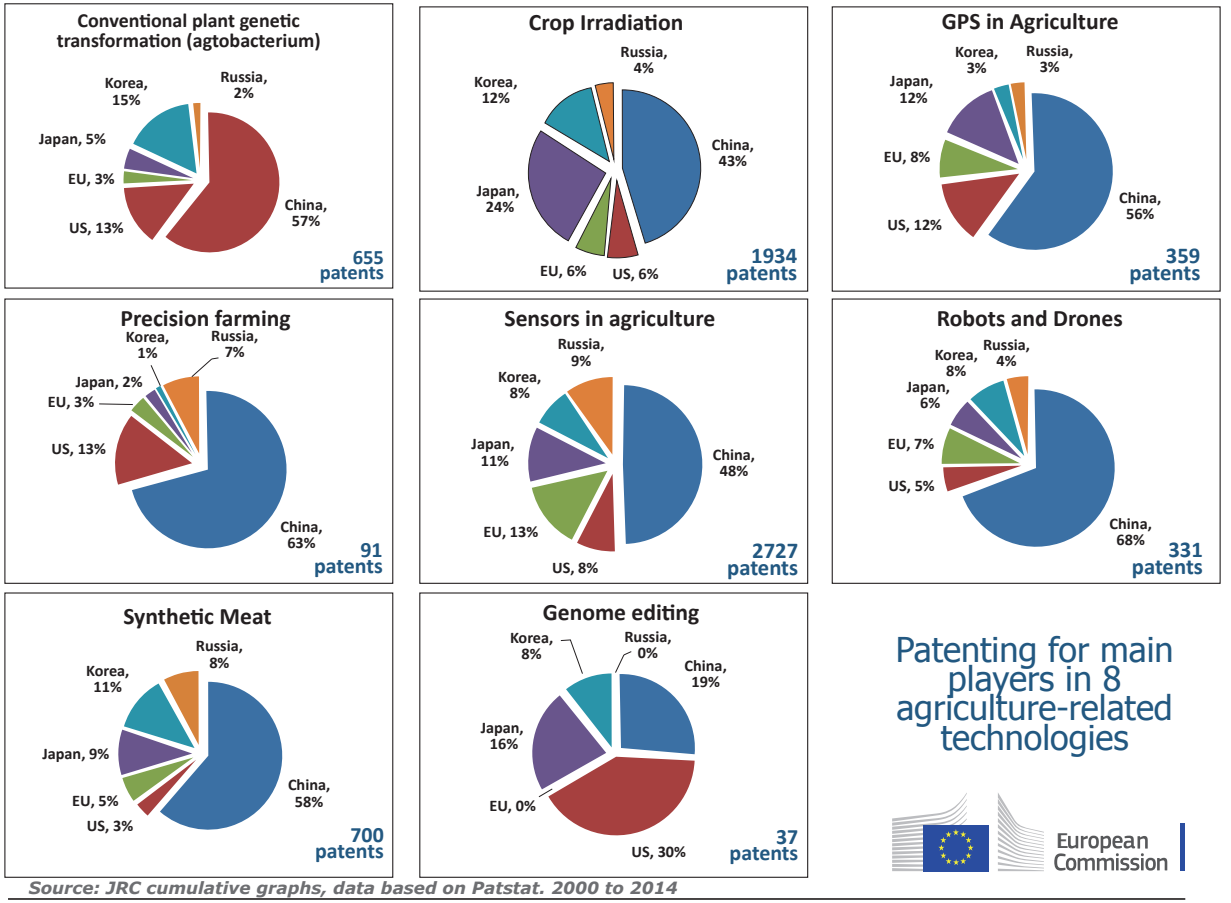
Based on the number of patents registered over the last fifteen years in eight key areas for the development of agriculture-related technologies, the European Commission's Joint Research Centre has provided the following overview:

Agricultural productivity has increased throughout history, and its impact on the environment has been modified only with the development of innovative solutions and their widespread use by farmers. Owing to the specificities of farms, this process has generally been driven by the State and the public authorities. More recently, private sector investment has partially replaced public sector intervention in the advanced economies, above all in the US.

However, without a broad-based revival of investment in innovation also involving the public sector in countries with a high per capita income, and without a redefinition of the existing systems to enhance the sharing of research results with the production chain, we can hardly imagine achieving the levels of productivity and of ecosystem management required by the current scenario.

IV – Edmond's gesture

Edmond is the name of the slave who revolutionised the cultivation of vanilla, the most used aroma in the food and industrial sector. In 1841, twelve-year-old Edmond, an orphan born in slavery in one of the world's outposts (Reunion Island, near Madagascar) and ignorant of botany as codified science, surpassed European experts by discovering how to pollinate the vanilla flower, aiding fertilisation by means of a toothpick-sized sliver of bamboo and a simple gesture.



Source: JRC cumulative graphs, data based on Patstat. 2000 to 2014

Figure 1 . Patenting in 8 agriculture-related technologies

Le geste d'Edmond (Ashton, 2015), as the French colonists called it, is still used today and marked a major breakthrough.

Vanilla was in great demand among the wealthy classes in Europe, but it was rare because its reproduction was considered mysterious. After 1841, plantations began to develop anywhere in the world with suitable climatic conditions, and demand grew together with supply, as often occurs when rare resources become abundant thanks to innovation. Prices started to fall and vanilla became more accessible.

The knowledge transfer involved in teaching Edmond's gesture, first to the growers in the island's plantations and then increasingly further afield, made it possible to increase production from a few thousand to 5 million vanilla pods between 1841 and 2010. Nowadays, countries like Indonesia, China and Kenya are great players in the supply of vanilla to many sectors ranging from the food industry to cosmetics.

Rather than being the invention of a genius, vanilla was the result of a "chain reaction" (Ashton, 2015). Edmond was not totally unaware of the science of plant organisms. His master, Ferréol Bellier Beaumont, had told him about the work of the late 18th century German naturalist Konrad Sprengel on the sexual reproduction of plants, and had demonstrated this principle by manually fertilising water melons. Not only did Bellier Beaumont free Edmond from slavery and insist that the boy be recognised as the inventor of the method, but he also worked hard to transfer this method to other growers. This dissemination activity, which would be called today innovation brokerage, is after all just one example out of many that can be diffused around the world.

Despite the enormity of its consequences, Edmond's gesture was a typical incremental innovation, a small step and not the mythological "great leap" forward which common sense attributes to invention. Of utmost importance is that Edmond's gesture was purely practical, a cost-free and easily replicable innovation. Rather than the gesture *per se*, what really counted were the information and the knowledge transfer, alongside a great social demand.

This story tells us that innovation is primarily a collective and social process, based on learning and interaction. Like the apples and the livestock cited earlier in this chapter, which are regarded as "natural" although they could not exist without human creative effort, innovation in agriculture and in other sectors is a collective work mostly done by anonymous players and requiring continuous adjustment, dictated by a dynamic relationship between needs and creativity, and by the exchange of knowledge for mutual learning.

Precisely to facilitate the exchange of views, at least from the 16th and the 17th centuries onwards, after the successful establishment of botanical gardens and the development of modern science in Europe, innovation in agriculture has been codified in knowledge transfer systems and models. Each period has had its own prevailing organisational model, its "paradigm" (Kuhn, 1962), to support the participation of farmers and scientists in innovative processes. The phase we are now experiencing has all the features of a transition between models, with many possible directions.

During this transition stage it is possible to compare, try and adapt different general approaches to different real situations.

The coexistence, comparison and fusion of a vast array of models and solutions could favour the alignment of agricultural innovation systems with the great challenges of the present, enabling them to find the best ways of adapting to local needs.

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