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Attitudes and behaviour of adopters of technological innovations in agricultural tractors: A case study in Italian agricultural system

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ABSTRACT

Agricultural system has a significant application of technology innovations, such as agricultural tractors, which are the most important and widespread machine in this industry. The behaviour of tractors' users, concerning the introduction and adoption of innovative characteristics, has received low attention. The study here analyses the attitude and opinion of a sample of Italian users of agricultural tractors, concerning some innovations, to outline different profiles of behaviour. The sample is based on 228 farmers, contractors and employees, participating at International Exhibition of Agricultural Machinery. Data are analysed by Multiple Correspondence Analysis and Cluster Analysis. The results show three separate groups of adopters of agricultural tractors by their attitude towards technological innovations in these vital machines: the "Unwilling" users, neither use innovative tractors, nor would like to have tractors equipped with new technological innovations, the "Willing-Cultural" users have traditional machines but would like to have innovative tractors in the future, and the "Innovative-Owner" adopters have and use ground-breaking tractors.

In particular, the "Unwilling" category identifies a not negligible market for manufacturers, requesting very essential tractors without any innovative features. The "Innovative-Owner" category, by a market pull model, can support the technological trajectory of the tractors' manufacturers due to their high degree of adoption of new technologies and interest in further new innovations. The attitude by "Willing-cultural" users may originate an additional trajectory of innovation for tractors and a new business opportunity for manufacturers, based on low cost or simplified version of complex innovative features in tractors. These different profiles can be useful to manufactures and innovation developers to better identify target-adopters, to develop innovations that satisfy needs of wide segments of adopters, and speed up technology transfer. Furthermore, the knowledge of these profiles could be useful for policymakers to support fruitful policy in agricultural systems.

1. Introduction and background

Technological innovation plays a major role in agricultural systems (Ball and Norton, 2002; Coccia, 2005a, 2009a; Ferrari et al., 2013; Pardey et al., 2010; Reece, 1999; Wright, 2012). In particular, agriculture industry has had exceptional advances and application of new technologies, revolutionising the farming (Coccia, 2009a; Sassenrath et al., 2008). Technological innovations are largely applied to agricultural tractors, enabling more efficient production and use of energetic resources, associated to both lower environmental impact and improvement of drivers' working conditions (Day et al., 2009; Korsching, 2001). In fact, the tractor has a central role in farm operations and remains the most important and widespread path-breaking machine in agriculture (Iftikhar and Pedersen, 2011). It pulls, lifts, powers, supports and is often the main status symbol of the agricultural enterprise. Moreover, it is common to find individual farmers faithful to one particular brand (Day et al., 2009). Of course the technology incorporated in a tractor has a considerable influence on production costs and, as a consequence, on retailer price (Von Pentz, 2011). The demand for agricultural machinery strongly depends on farm income, which is influenced by external variables such as agricultural policy, socio-economic environment, people's attitudes, weather and public policies (Vieweg, 2012).

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In recent years structural changes in agricultural systems have affected income and investment, increasing the level of uncertainty and reducing the farmers' propensity to invest in new equipment (Bonati and Gelb, 2005; Vieweg, 2012). In the sixties the high-income countries (Europe, North America, Japan and European Eastern countries) accounted for 43.8% of total global agricultural output, while in 2010 their contribution is reduced to a mere 25.5% (Alston and Pardey, 2014). In these countries, in the last fifty years, the high wages have reduced the total amount of labour employed in farming and the number of people living on farms, with commensurate increases in farm sizes (Alston and Pardey, 2014). In the same time span the stock of tractors almost doubled and the use of modern land- and labour-saving inputs has significantly increased (Alston and Pardey, 2014). Since eighties the agricultural intensification has partially generated the decline of biodiversity and ecological disruptions (Donald et al., 2001). In the European Union countries, since 1992, the Common Agricultural Policy (CAP) has changed from price and production interventions to a policy of direct income aid and rural development (Rabbinge and Van Diepen, 2000; European Union, 2012). CAP has also supported the aims of sustainability, environmental protection and societal goals. The implementation of this strategy has generated fruitful results in agricultural systems (Gil, 2010).

In 2010 there were 12.2 million farms across the 28 countries of the European Union (EU-28), working 174.1 million hectares (ha) of land (the Utilized Agricultural Area), representing 40% of the total land area of the EU-28. The average size of each agricultural holding (farm) was 14.2 ha (Eurostat, 2013). There were a large number (6 million or half of all holdings) of very small farms (less than 2 ha in size) that farmed a small proportion (2.5%) of the total land area used for farming, while a small number (2.7% of all holdings) of very large farms (over 100 ha) farmed almost half (50.2%) of the farmland in the EU-28 area (Eurostat, 2013). This difference affects the economic size of holdings: 5.5 million holdings (44.6%) had in 2010 a standard output below € 2000 and were responsible for only 1.4% of total agricultural economic output, while 1.9% of holdings had a standard output in excess of € 250,000 accounted for 47.8% of all agricultural economic output (Eurostat, 2013). If we compare the United States, in 2012, the number of farms was estimated at 2.17 million and the total land in farms at 370 million ha. The average farm size in US was 170 ha with great differences among States: Rhode Island had the smallest farm's average size, roughly 23 ha, while Montana had the largest one: 1131 ha (USDA, 2013). In 2012 USA farms with an income lower or equal to $ 10,000 were 54% and farmed 10.8% of the total land, while farms with income higher than $ 250,000 absorbed about 50% of the land (USDA, 2013).

In 2010, one out of four of the EU-28's holdings was in Italy (13.2%), on average 7.9 ha in size (Eurostat, 2013; Inea, 2012). In 1990 the average Italian farm's Utilized Agricultural Area (UAA) was 5.5 ha. The number of Italian farmers decreased from 2.6 million in 1990 to 1.62 million in 2010. During the same period, the UAA in Italy declined from nearly 15 million to 12.9 million ha. Although there is an increase in average size of the business, Italian agriculture continues to be characterized by a very large number of very small companies that affects the economic performance of the sector. Small farms, with less than 2 ha of UAA, represent 50.6% of the total UAA, while holdings with a standard value production of less than € 8000 represent 62% of the total Italian farms, accounting for only 5.3% of the total standard production of domestic agriculture. Farms with such modest economic weight have low investments on expensive machinery and contractors assume an important role. The latter can provide a large number of services to the farming industry, typically dealing with land, fields, or crops, including for example, fertilization, chemical applications, harvesting crops and manure spreading. In Italy the number of these operations is estimated to be more than 10,000.

In addition, Italy has about 310,000 (19% of the total) holdings with a size and income that can be considered real "business". These companies account for almost 90% of the Italian standard production, whose total value amounts to approximately € 49.5 billion (Inea, 2012).

Italian agricultural system is based on farms that have about 1.75 million tractors in 2008 (Unacoma, 2008), such that Italy is in 3rd place in tractor fleet after USA and Japan (World Resources Institute, 2012). This means that Italian farms tend to have a tractor density of approximately 138 units per 1000 ha; it is a very high ratio if compared with Germany (85.8), France (64.5) and US (26.8) (World Resources Institute, 2012). As well as, Italy is a world leader in tractor production (Unacoma, 2008). In particular, Italian agricultural machinery manufacturing industry is made up of large globally active groups and small and specialized companies.

Italian and European farmers have to take into account this entire context when they invest in new technology (cf. Coccia, 2005c, 2007). It is unlikely for farmers to adopt innovations as soon as they appear on the market; investment lags are frequently explained by their economic attribute, and more specifically, by the uncertainty about the future value of investments and sunk costs (Marra et al., 2003; Tozer, 2009). Adoption of a new technological machine is often a difficult decision, though it shows obvious economic advantages (cf. Rogers, 1995).

The analysis of adopters of technological innovation, the recipient absorbing technology, is important to evaluate their behaviour in using new technologies and to support appropriate innovative strategies of firms in turbulent and fast-changing markets (Bunduchi et al., 2011; Coccia, 2004a, 2005b, 2008, 2010a; Macrì et al., 2001; Yu and Tao, 2009). Economic and managerial research can facilitate companies to develop new products, to better and quickly satisfy users' needs, and therefore customer requirements in terms of innovative products that they subsequently purchase (Calabrese et al., 2005; Dunk, 2004; Jeffrey and Franco, 1996).

In brief, current R&D investments in advanced countries, associated to other factors, support technological change to spur productivity of industries and economic growth (see Coccia, 2009b, 2010a, 2010b, 2012, 2013, 2014a, 2014b). Different theories have been developed to describe and assess the adoption and diffusion of technology (Burkman, 1987; Carr, 2001; Coccia, 2004a, 2004b, 2005a, 2009a; Farquhar and Surry, 1994; Macrì et al., 2001; Marra et al., 2003; Rogers,1995; Stockdill and Morehouse, 1992), the mechanisms and main issues concerning technological absorption of adopters and their geo-economic space (Coccia, 2005b, 2008, 2010a, 2010b, 2010c; Cohen and Levinthal, 1990; Kingsley et al., 1996; Macrı et al., 2001; Young, 2009, p. 1900; Yu and Tao, 2009), and the role of users in the process of technological development (Bunduchi et al., 2011; Oudshoorn and Pinch, 2005). Furthermore, the adoption of technological innovation can be considered a phase of the technology transfer (Coccia, 2005b, 2008, 2010a): a subject acquires technical knowledge and/or new technology from the source (Cutler, 1989). In general, the users (or adopters) link the technological knowledge to the ease of acquisition, comprehension and application of the technology (Coccia, 2004a, 2005a, 2005b, 2008, 2010a; Coccia and Rolfo, 2002).

Users of agricultural tractors have had for many years a passive role without contributing to the R&D process of leading firms (cf. Coccia, 2014c; Douthwaite et al., 2001). Over the past decade the importance of adopters has emerged, in line with a market-pull approach to support fruitful technological trajectories in several industries such as in agriculture (Glenna et al., 2011). Although consumers have received considerable attention in R&D, there is a dearth of economic studies on the impact of farmer perceptions in the agricultural sector (Gasparin et al., 2008); in fact, fragmented information are available on attitude of adopters towards technological innovations in agricultural tractors (Cavallo et al., 2014a,