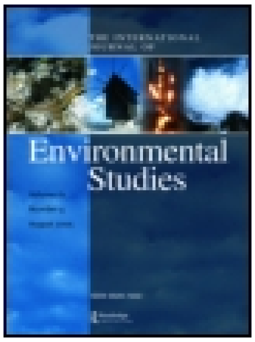

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ABSTRACT

Conservation Agriculture (CA) comprises the practical application of three interlinked principles, namely: no or minimum mechanical soil disturbance, biomass mulch soil cover and crop species diversification, in conjunction with other complementary good agricultural practices of integrated crop and production management. In 2015/16, CA was practised globally on about 180 M ha of cropland, corresponding to about 12.5% of the total global cropland. In 2008/09, the spread of CA was reported to be about 106 M ha. This change constitutes an increase of some 69% globally since 2008/09. In 2015/16, CA adoption was reported by 78 countries, an increase in adoption by 42 more countries since 2008/09, respectively. The average annual rate of global expansion of CA cropland area since 2008/2009 has been some 10.5 M ha. The largest extents of adoption are in South and North America, followed by Australia and New Zealand, Asia, Russia and Ukraine, Europe and Africa.

KEYWORDS
No-till; mulch; crop diversification; sustainability; adoption; policy

Introduction

The environmental footprint of agriculture

Agricultural intensification based on tillage-based agriculture, has, at all levels of economic development, had a negative effect on the quality of the essential natural resources such as soil, water, terrain, biodiversity and the associated ecosystem services provided by nature [1–3]. This degradation of the land resource base has caused crop yields and factor productivities to decline and has promoted the practice of an alternative production paradigm that is ecologically sustainable as well as profitable [2,4]. Another challenge for agriculture is its environmental footprint and climate change. Agriculture is responsible for about 30% of the total greenhouse gas emissions of CO_2, N_2O and CH_4 and is directly affected by the consequences of a changing climate [5]. The effects of climate change are felt more and more in agriculture and other sectors because extreme climatic events occur with higher frequency and have more severe impact. This is not always because the extreme events are more extreme than in the past, but because they are affecting degraded ecosystems which no longer perform the basic ecosystem functions, such as water infiltration and maintenance of water cycles.

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FAO has elaborated a new paradigm of 'sustainable production intensification' [6] which recognises the need for a productive and remunerative agriculture that can conserve and enhance the natural resource base and environment, and so contributes to harnessing land-mediated ecosystem services for the benefit of society. In addition, it is necessary to enhance the resilience of the production systems to biotic and abiotic stresses and shocks, particularly those arising from the impact of climate change on crop production. Sustainable crop production intensification must both reduce the impact of climate change on crop production and also be 'climate smart' in mitigating the factors that cause global warming by reducing greenhouse gas emissions and by contributing to carbon sequestration in the soil. Enhancing biodiversity in crop production systems above and below the ground to improve ecosystem services leads to better productivity, healthier environment and improved resilience against climatic stress factors. Degradation of agricultural land and ecosystem services must be avoided by all means. Agricultural land degraded by past abuse must be rehabilitated [2].

The alternative no-till system paradigm known as Conservation Agriculture (CA) can meet all these objectives [2,4,7–10]. CA save on energy and mineral nitrogen use in farming and thus reduces greenhouse gas emissions; it enhances biological activity in soils, resulting in long-term yield and factor productivity increases, as well as increases in overall system-level biomass production [6,11,12].

Description of CA

FAO defines CA as an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA is characterised by the practical application of three linked principles, along with other complementary good agricultural practices of crop and production management, namely [13]:

(1) Principle 1: Continuous no or minimal mechanical soil disturbance (implemented by the practice of no-till seeding or broadcasting of crop seeds, and direct placing of planting material into untilled soil; and causing minimum soil disturbance from any cultural operation, harvest operation or farm traffic);
(2) Principle 2: Maintenance of a permanent biomass soil mulch cover on the ground surface (implemented by retaining crop biomass, root stocks and stubbles and cover crops and other sources of *ex situ* biomass); and
(3) Principle 3: Diversification of crop species (implemented by adopting a cropping system with crops in rotations, and/or sequences and/or associations involving annuals and perennial crops, including a balanced mix of legume and non-legume crops).

CA systems are now in existence in all continents in all land-based agriculture, supporting the notion that CA principles are universally applicable to all agricultural landscapes and land uses with locally formulated and adapted practices. The three individual principles when applied concomitantly constitute the ecological foundation of CA systems. If the three principles are applied separately, they *do not* constitute a CA system. For example, the use of no-till practice on its own does not qualify the production system to be CA based, unless it is linked to the application of the other two practices of soil mulch cover and diversified cropping.

CA enhances biodiversity and natural biological processes above and below the ground surface. Soil interventions such as mechanical tillage are reduced to an absolute minimum or avoided, and external inputs such as agrochemicals and plant nutrients of mineral or organic origin are applied optimally and in ways and quantities that do not interfere with, or disrupt, the biological processes [13].

CA in this way facilitates good agronomy, such as timely operations, and improves overall land husbandry for rain-fed and irrigated production. Complemented by other known good practices, including the use of quality seeds, and integrated pest, nutrient, weed and water management, etc., CA is a base for sustainable agricultural production intensification [2,4,9,10,14].

Established CA systems achieve yield levels comparable with and even higher than those under conventional intensive tillage systems. CA *does not* necessarily lead to yield penalties. Further, the overall crop and biomass production within a season increases over time under CA management compared to tillage-based management, since unproductive times used for tillage and land preparation are excluded and soil moisture and carbon are conserved. At the same time, CA complies with the generally accepted ideas of ecological sustainability because the three principles when implemented act like land with natural vegetation [2–4,15–17]. Increased cropping system diversity and stimulation of biological processes in the soil and above the soil surface, combined with reduced erosion and leaching, can lead to increased retention and use of water and nutrients and a decline in the application of mineral fertiliser and pesticides, including herbicides, in the longer term. Ground water resources are replenished through better water infiltration and reduced surface runoff. Water quality is improved because of reduced contamination levels from agrochemicals and soil nutrient through reduced leaching and soil erosion [18].

Further, CA has been proved to sequester organic carbon in soil at a rate ranging from about 0.1–0.5 t/ha/year or more depending on the amount of biomass being returned, prevailing soil organic carbon content, thermal and moisture climate, length of growing season, soil type and fertility, cropping systems and management practices [19–22]. Labour requirements are generally reduced by about 50%, which allows farmers to save on time, fuel and machinery costs [23–27]. In general, fuel savings in the order of around 60% or more are reported [28–30].

History and adaptability of CA

Tillage, as a soil management concept was questioned for the first time in the 1930s, when the dustbowls devastated wide areas of the mid-west United States [31]. Ideas for reducing tillage and keeping soil covered with crop biomass followed and the term conservation tillage was introduced for practices aimed at erosion control. Seeding machinery developments allowed then, in the 1940s, to seed directly without any soil tillage. At the same time, theoretical concepts resembling today's CA principles were elaborated by Edward Faulkner in his book *Ploughman's Folly* [32] and Masanobu Fukuoka with the 'One Straw Revolution' [33]. But only in the 1960s did no-tillage enter into farming practice in the USA [16,34,35].

In the early 1970s and as the result of uncontrollable erosion problems in the southern states, no-tillage reached Brazil, where farmers together with scientists transformed the technology into the system which today is called CA. Yet it took another 20 years before CA reached significant adoption levels. During this time, farm equipment and agronomic practices in no-tillage systems were improved and developed to optimise the performance of crops, machinery and field operations. This process continues; the creativity of farmers and researchers is still producing improvements to the benefits of the production system, the soil and the farmer. While tillage-based agriculture has been researched for several centuries, CA is only half-a-century old and the functioning of CA systems can only be understood as the agro-ecosystems evolve under the new production management. From the early 1990s, the uptake of CA started growing exponentially, leading to a revolution in the agriculture of southern Brazil, Argentina and Paraguay and Uruguay.

During the 1990s, this development increasingly attracted attention from farmers and researchers in Europe, Asia, Africa and Australia, and from development and international research organisations such as FAO, World Bank, IFAD, GIZ, NORAD, CIRAD, ACIAR and the CGIAR system. Study tours to Brazil for farmers and policy-makers, and regional workshops, development and research projects were organised in different parts of the world. These produced increased levels of awareness and adoption in African countries such as South Africa, Zambia, Zimbabwe, Mozambique, Tanzania and Kenya as well as in Asia, particularly in Kazakhstan, India, Pakistan and China. The improvement of conservation and no-tillage practices within an integrated farming concept such as CA also led to a cropping system diversification and increased adoption of CA in industrialised countries after the end of the millennium, particularly Canada, USA, Australia, Spain, Italy, Finland, Ukraine and Russia [36]. The spread of CA has continued to more countries in Europe, Asia and Africa [37,38].

CA crop production systems are popular worldwide. There are few countries where CA is not practised by at least some farmers and where there are no local research results about CA available [9]. The total cropland area under CA in 2008/09 was estimated to be 106 M ha [4,39]. By 2010/11, the global spread of CA had to be corrected from the original estimates from 125 M ha [40] to 145 M ha because it had not been possible to record all the increases. For 2013/14, the global total CA cropland area was initially estimated to be 155 M ha [37] but was corrected to be 157 M ha because of the increase in CA area in Argentina which had not been reported at the time of the 2013/14 figures (see database at http://www.fao.org/ag/ca/6c.html) [41]. As reported in Section **Adoption** below, the latest global estimate for CA cropland reported for 2015/16 is about 180 M ha.

CA systems are widely adaptable. Their presence extends: from the equatorial tropics (e.g. Kenya, Tanzania, Uganda) to the arctic circle (e.g. Finland) North and to about 50º latitude South (e.g. Falkland Islands); from sea level in several countries of the world to 3000 m altitude (e.g. Bolivia, Colombia); from heavy rainfall areas with 2000 mm a year (e.g. Brazil) or 3000 mm a year (e.g. Chile) to extremely dry conditions in the Mediterranean environments with 250 mm or less a year (e.g. Morocco, Syria, Western Australia) [9,36].

CA is practised on soils that vary from 90% sand (e.g., North Africa, southern Mediterranean zone, coastal zones in tropical Africa, Australia) to 80% clay (e.g., Brazil's

Oxisols and Alfisols). Soils with high clay content in Brazil or in Europe are extremely sticky but this has not been a hindrance to no-till adoption when appropriate equipment is available. Soils that are readily prone to crusting and surface sealing under tillage farming do not exhibit this problem under established CA systems. This is because minimum soil disturbance, mulch cover and increased soil organic matter all contribute to enhancement of soil quality that avoids the formation of crusts. In some countries, CA has even allowed expansion of agriculture to marginal soils in terms of rainfall or fertility (e.g., Australia, Argentina). In southern Brazil, CA has facilitated the restoration of the degraded savanna and forest soils – the *cerrados* – to productive agricultural lands [9,36].

No-tillage in CA is practised on all farm sizes from less than half a hectare or a few hectares (e.g., India, China, Zambia, Zimbabwe, Brazil and Paraguay) to thousands of hectares (e.g., Argentina, Brazil, South Africa, Australia and Kazakhstan). All crops can be grown adequately in CA systems and to the authors' knowledge, there has not yet been a crop that would not grow and produce under this system, including root and tuber crops [39,42].

Despite the existence of several constraints to adoption, farmers in different parts of the world are continuing to find local solutions to support the spread of CA as well as to innovate with new practices and management methods to maximise the benefits. Major constraints to the adoption of CA practices continue to be: knowledge about the existence of CA and on how to do it (know how), mind-set (tradition, prejudice), inadequate policies, for example, commodity-based subsidies (EU, US) and direct farm payments (EU), unavailability of appropriate equipment and machines (many countries of the world) and of suitable management strategies to facilitate weed and vegetation management, including mechanical, biological and chemical options as herbicides (especially for larger farms in low-income countries) [9,10,43]. Other area-specific constraints in semi-arid areas during the transformation to CA system relate: to initial low supply of crop and vegetation biomass for soil mulch cover development; to initial short-term competition for crop residue as livestock feed; and to initial adoption of new manual weed management practices when the soil mulch cover and integrated weed management practice is being established.

Yet farmers who do become seriously interested in adopting CA develop local solutions to all these barriers. Many such cases have been reported for smallholder and large-scale farms in all continents (see list of publications at: www.fao.org/ag/ca). Further, more international and national organisations have increased their support for CA as they have increased their awareness of its effectiveness in sustainable production intensification. These organisations include: FAO, IFAD, World Bank, EU, New Partnership for Africa's Development (AU-NEPAD), CIRAD, African Conservation Tillage (ACT), some CGIAR Centres (CIMMYT, ICARDA, ICRISAT, ICRAF), NGOs, some governments in the North and the South, national and multi-national corporations, the growth of no-till/CA organisations worldwide, farmer-to-farmer support, even across continents, and bilateral and multi-lateral donors. Thus, the continuing spread of CA globally is creating a need for effective national and regional policy and institutional support [44,45].

Adoption

Farmer-led transformation of agricultural production systems based on CA is progressing globally. Since 2008/09, the adoption has increased exponentially with the impulse of the need for a new paradigm for 'sustainable intensification of crop production' including the delivery of ecosystem services and as a base for 'climate smart agriculture'.

The information on the adoption of CA in 2015/16 presented in this paper applies only to 'arable' cropland and is based on several sources: government statistics (e.g. Canada and USA), survey estimates by no-till farmer organisations (e.g. Australia, Brazil, Argentina, Paraguay and Uruguay), by Ministry of Agriculture (e.g. China, Malawi, Zimbabwe), NGOs (e.g. Europe, Russia, Madagascar, Zambia), well-informed individuals from research and development organisations (e.g. Pakistan, India, Kazakhstan, Ukraine). The database is up to date for 2015/16 for most countries with exceptions including: Ukraine, India, DPR Korea, Lebanon, Azerbaijan, Chile, Colombia, Mexico, Venezuela, Kenya, Ghana and Sudan. For these countries, the information from 2013/14 is used in this paper. Besides, since 2013/14, CA annual cropland systems have been recorded in more countries such as Uganda, Swaziland and Algeria in Africa; in Asia, Pakistan, Tajikistan, Iran, Bangladesh, Laos, Vietnam and Cambodia; and in Europe, Austria, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Latvia, Lithuania, Luxemburg, Poland, Romania, Slovenia and Sweden.

There are surveys of adoption of CA in individual countries in 2008/2009 [4,39], in 2010/11 [35,40] and in 2013/14 [38]. There is an *interim* record of the global spread of CA in 2015/16 [46], and this paper refines matters by including data for more countries and also correcting any previous errors, particularly related to information from countries in Africa. There are also global state-of-the-arts reviews of CA [9,10], and for Africa in [8].

Unfortunately global data of CA adoption in cropland are not officially reported, but collected from the above-mentioned sources. Until recently, FAO provided, with their AQUASTAT database, a platform for the publication of adoption data. For data collection to correct the database, the CA definition has been quantified as follows for CA cropland for each of the three interlinked CA applied principles, and has been used since 2008/09:

(1) *Continuous no or minimum mechanical soil disturbance*: Refers to permanent low soil disturbance no-tillage, and includes no-till direct seeding and no-till weeding. The disturbed area for crop establishment must be less than 15 cm wide or less than 25% of the cropped area (whichever is lower). There should be no periodic tillage that disturbs a greater area than the aforementioned limits. In special cases, low soil disturbance strip or band seeding is allowed if the disturbed surface area is less than the set limits.

(2) *Permanent soil mulch cover with biomass*: Soil mulch cover is achieved with biomass from crop residues, stubbles and cover crops. Three categories are distinguished: 30–60%, >60–90% and >90% ground cover, measured immediately after the direct seeding operation. Area with less than 30% cover is not considered as CA.

(3) *Crop diversification through rotations/sequences/association*: Should ideally concern at least three different crops. Repetitive wheat, maize or rice cropping is not an exclusion factor for the purpose of this data collection, but rotations/sequences/associations are noted where practised.

Global

It was estimated that the global extent of CA cropland in 2008/09 covered about 106 M ha (7.5% of global cropland) [4]. In 2013/14, it was about 157 M ha (11% of global cropland), representing a difference of some 51 M ha (some 47%) over the 5-year period (Table 1) [38]. In 2015/16, CA cropland was about 180 M ha (12.5% of global cropland), representing a difference of some 74 M ha (69%) over the 7-year period since 2008/09 or about 23 M ha (some 15%) over the 2 years since 2013/14.

CA in recent years has become a fast-growing production system for many reasons including: greater factor productivity and farm output, reducing cost of production and improving profitability, greater resilience to biotic and abiotic stresses, minimising soil erosion and degradation, building soil health, adapting to and mitigating climate change [2,8–10]. Whereas in 1973/74, CA was applied on only 2.8 M ha worldwide (Figure 1), the area had grown to 6.2 M ha in 1983/84 and to 38 M ha in 1996/97 [31]. In 1999, worldwide adoption was 45 M ha, and by 2003, the area had grown to 72 M ha. During the period from 1999 to 2013, CA cropland area had expanded at an average rate of about 8.3 M ha per year, from 72 to 157 M ha [38].

Since 2008/09, the rate of change has increased to about 10.5 M ha, from 106 to 180 M ha, showing the increased interest of farmers in the CA farming system approach to sustainable production and agricultural land management. Earlier, this expansion was mainly in North and South America and in Australia and New Zealand. More recently, it is also occurring in Asia, particularly in Kazakhstan and China with large farms, and in India and Pakistan with small farms. Wheat-based CA cropping systems have been spreading in these countries in recent years. In Kazakhstan and China, rainfed wheat systems are being transformed into CA systems. Crop diversity is increasing as research has shown the feasibility of integrating legumes in the rotations. In India and Pakistan, wheat–rice cropping systems in the Indo-Gangetic Plains are being transformed into CA systems, referred to as 'double no-till' rice–wheat systems, and in some cases there is an added short season legume crop. Major increases in the adoption of CA cropping systems are expected across Asia in the coming decades. The situation is also changing in Africa where more smallholder farmers are taking up CA, particularly in eastern and southern Africa, and medium-scale farmers in North Africa. CA in Europe, and in Russia and Ukraine, has been expanding steadily during the past decade. These trends are expected to continue.

Since 2008/09, the number of countries where CA adoption and uptake is occurring has increased from 36 to at least 55 in 2013/14 and to 78 in 2015/16, as shown in Table 1. The table does not include several countries where CA is known to be practised, but either at very small levels or without being reported in any systematic form. They are a significant list: Ethiopia, Rwanda, Burkina Faso, Senegal and Cameroon in Africa; Jordan, Nepal, Timor Este and Philippines in Asia; Cuba, Costa

Table 1. Extent ('000 ha) of adoption of CA worldwide by country in 2008/09, 2013/14 and 2015/16.

No	Country	CA area 2008/09	CA area 2013/14	CA area 2015/16
1	USA	26,500.00	35,613.00	43,204.00
2	Brazil	25,502.00	31,811.00	32,000.00
3	Argentina	19,719.00	29,181.00	31,028.00
4	Canada	13,481.00	18,313.00	19,936.00
5	Australia	12,000.00	17,695.00	22,299.00
6	Paraguay	2400.00	3000.00	3000.00
7	Kazakhstan	1300.00	2000.00	2500.00
8	China	1330.00	6.670.00	9000.00
9	Bolivia	706.00	706.00*	2,000.00
10	Uruguay	655.10	1072.00	1260.00
11	Spain	650.00	792.00	900.00
12	South Africa	368.00	368.00*	439.00
13	Germany	354.00	200.00	146.00
14	Venezuela	300.00	300.00*	300.00#
15	France	200.00	200.00*	300.00
16	Finland	200.00	200.00	200.00
17	Chile	180.00	180.00*	180.00#
18	New Zealand	162,00	162.00*	366.00
19	Colombia	102.00	127.00	127.00#
20	Ukraine	100.00	700.00	700.00#
21	Italy	80.00	380.00	283.92
22	Zambia	40.00	200.00	316.00
23	Kenya	33.10	33.10*	33.10#
24	United Kingdom	24.00	150.00	362.00
25	Portugal	25.00	32.00	32.00#
26	Mexico	22.80	41.00	41.00#
27	Zimbabwe	15.00	90.00	100.00
28	Slovakia	10.00	35.00	35.00#
29	Sudan	10.00	10.00*	10.00#
30	Mozambique	9.00	152.00	289.00
31	Switzerland	9.00	17.00	17.00#
32	Hungary	8.00	5.00	5.00#
33	Tunisia	6.00	8.00	12.00
34	Morocco	4.00	4.00	10.50
35	Lesotho	0.13	2.00	2.00
36	Ireland	0.10	0.20	0.20
37	Russia	–	4500.00	5000.00
38	India	–	1500.00	1500.00#
39	Malawi	–	65.00	211.00
40	Turkey	–	45.00	45.00
41	Moldova	–	40.00	60.00
42	Ghana	–	30.00	30.00#
43	Syria	–	30.00	30.00#
44	Tanzania	–	25.00	32.60
45	Greece	–	24.00	24.00#
46	Korea, DPR	–	23.00	23.00#
47	Iraq	–	15.00	15.00#
48	Madagascar	–	6.00	9.00
49	Uzbekistan	–	2.45	10.00
50	Azerbaijan	–	1.30	1.30#
51	Lebanon	–	1.20	1.20#
52	Kyrgyzstan	–	0.70	50.00
53	Netherlands	–	0.50	7.35
54	Namibia	–	0.34	0.34#
55	Belgium	–	0.27	0.27
56	Pakistan	–	–	600.00
57	Romania	–	–	583.82
58	Poland	–	–	403.18
59	Iran	–	–	150.00
60	Estonia	–	–	42.14

(*Continued*)

Table 1. (Continued).

No	Country	CA area 2008/09	CA area 2013/14	CA area 2015/16
61	Czech Republic	–	–	40.82
62	Austria	–	–	28.33
63	Lithuania	–	–	19.28
64	Croatia	–	–	18.54
65	Bulgaria	–	–	16.50
66	Sweden	–	–	15.82
67	Latvia	–	–	11.34
68	Uganda	–	–	7.80
69	Algeria	–	–	5.60
70	Denmark	–	–	2.50
71	Slovenia	–	–	2.48
72	Bangladesh	–	–	1.50
73	Swaziland	–	–	1.30
74	Tajikistan	–	–	1.20
75	Vietnam	–	–	1.00
76	Cambodia	–	–	0.50
77	Laos	–	–	0.50
78	Luxemburg	–	–	0.44
79	Cyprus	–	–	0.27
	Total	**106,505.23**	**156,738.96**	**180,438.64**
	% difference		**47.17 since 2008/09**	**69.42 since 2008/09** **15.12 since 2013/14**

*2013/14 values taken from 2008/09; #2025/16 values taken from 2013/14; *Source*: 2008/09 and 2013/14 estimates, FAO-AQUATSTAT [41]; 2015/16 estimates obtained directly by authors from same national sources.

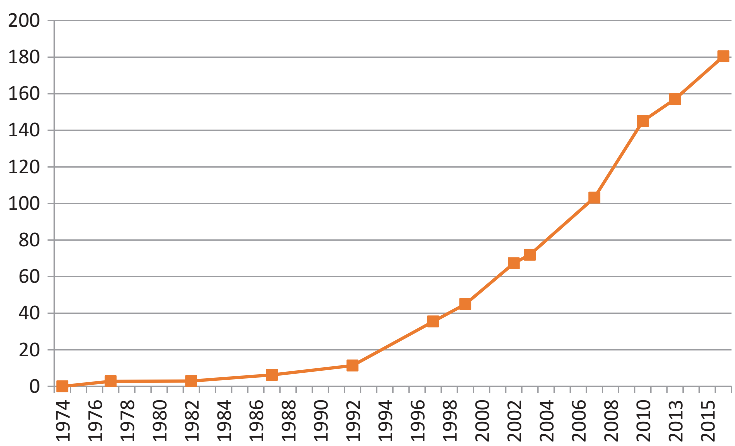

Figure 1. Global uptake of CA in M ha of cropland.

Rica, Honduras, El Salvador, Guatemala and Nicaragua in Central America. Further, the area of CA systems based on perennial crops such as in orchards and plantations or mixture of annual and perennial crops such as trees in association with annual crops, agroforestry systems, crop-livestock-tree systems or pasture systems *are not included* in the total CA area reported in this paper. Such CA systems with perennial crops are on the increase in all inhabited continents. CA orchards and vines concern crops such as olive, grape, fruit and nut trees. CA plantation systems concern crops such as oil palm, cocoa, rubber, tea, coffee and coconut but also sugar cane. Thus, the CA cropland areas reported in this paper are *conservative estimates* of global CA land use.

The growth of the area under CA has been especially significant in South America where the MERCOSUR countries (Argentina, Brazil, Paraguay and Uruguay) are using the system on more than 70% of their total cropland area.

As Table 2 shows some 69.9 M ha (38.7%) of the total global area under CA is in South America, corresponding to some 63.2% of the cropland in the region, and some 63.2 M ha (35.0%) is in North America, mainly in the USA and Canada, corresponding to 28.1% of the cropland of the region. Some 22.7 M ha (12.6%) is in Australia and New Zealand, corresponding to 45.4% of the cropland, and some 13.9 M ha (7.7%) is in Asia, corresponding to 4.1% of the cropland in the region. Some 10.8 M ha (6.0%) of the total global CA area is in the rest of the world, comprising 5.7 M ha in Russia and Ukraine, 3.6 M ha in Europe and 1.5 M ha in Africa, corresponding to about 3.6%, 5.0% and 1.1% of their total cropland area, respectively.

In terms of CA adoption and uptake, Europe and Africa are the developing continents.

Nevertheless, CA area in Europe of 3.6 M ha estimated in 2015/16 is greater by some 127.4% than the 1.56 M ha that was estimated in 2008/09. For Africa, the CA area of 1.5 M ha in 2015/16 corresponds to some 211% increase from 0.48 M ha in 2008/09. There has been this significant increase in CA area in Europe and Africa in recent years because many years of research in these continents have shown positive results for CA systems. There has also been the incentive of increased interest in CA systems shown by NEPAD, governments, European Commission (EC), NGOs such as ACT and European Conservation Agriculture Federation (ECAF) and the private sector, international organisations and donors.

The major drivers for CA adoption globally continue to be the need to increase input factor productivity, yield and total farm output, improved sustainability of production and farm land, better incomes, timeliness of cropping practices, ease of farming and reduction in drudgery, and improved ecosystem services such as clean water, control of erosion and land degradation, carbon sequestration, cleaner atmosphere and the rehabilitation of degraded agricultural lands [2,8–10]. The continuous growth of CA systems as shown in Figure 1 is largely a result of the initiative of farmers and their organisations. This is augmented by technical and financial support from governments, donor agencies and international organisations for CA research and development in Africa and Asia in recent years [8,47–49]. The uptake of CA in Africa and Asia is expected to accelerate in the coming years. When government policies support base-level initiatives, as in Kazakhstan and China, rapid growth rates occur [50,51].

Table 2. Cropland area under CA (M ha) by region in 2015/16; CA area as % of global total cropland, and CA area as % of cropland of each region.

Region	CA Cropland area	Per cent of global CA cropland area	Per cent of Cropland area in the region
South America	69.90	38.7	63.2
North America	63.18	35.0	28.1
Australia & NZ	22.67	12.6	45.5
Asia	13.93	7.7	4.1
Russia & Ukraine	5.70	3.2	3.6
Europe	3.56	2.0	5.0
Africa	1.51	0.8	1.1
Global total	**180.44**	**100**	**12.5**

In many countries such as the USA, Canada, Australia, New Zealand, Brazil, Argentina, Paraguay, Uruguay, South Africa, Zambia, Zimbabwe, Malawi, Mozambique, Namibia, Kazakhstan, India and China, CA is being 'mainstreamed' in national agricultural development programmes or backed by suitable policies and institutional support. Consequently, the total area under CA worldwide has increased by 69.4% since 2008/09, from 106 M ha (7% of global cropland) to 180 M ha (12.5% of global cropland) in 2015/16. The adoption of CA globally since 1990 has been growing mainly in North and South America and in Australia, and more recently in Asia in particularly Kazakhstan, China, India and Pakistan, and in Europe especially in Spain, Italy, the UK and France, and in Russia, and in Africa including Zambia, Zimbabwe, Malawi, Mozambique, South Africa, Tunisia and Morocco. Thus, the area under CA is expanding in all regions of the world and large areas of global agricultural land, including those under orchards and plantation systems, agroforesty systems and crop–pasture–tree systems are expected to transform to CA systems in the coming years and decades.

So far, most of the CA development has been in rain-fed annual cropping systems and some in irrigated crops in combination with rain-fed crops such as the rice–wheat cropping system in the Indo-Gangetic Plains. The same CA principles apply for strengthening the ecological and economic sustainability of *irrigated systems*, including those in arid and semi-arid areas, with the additional benefit of improving water use efficiency and avoiding or minimising salinisation problems. This is happening in the tropics and sub-tropics with irrigated rice-based systems in Brazil, Argentina, Pakistan, India and Bangladesh, with other cropping systems such as irrigated cotton-based systems in Uzbekistan and in irrigated systems in Spain and Italy.

As indicated earlier, CA principles and practices are also applicable for orchards, plantations and vine crops with the direct sowing of associated field crops, cover crops and pastures beneath or between rows, giving permanent ground cover and biomass production, controlling soil erosion, improving soil health and biodiversity, water infiltration and retention, and soil aeration. In the dry areas of Africa, there is an increase of agroforestry systems integrating nitrogen fixing trees such as *Faidherbia albida* with CA systems [52]. Orchard crops and vines are being converted into CA systems in Europe [53]. Plantation tree crops such as oil palm, rubber, cocoa, citrus and coconut are also being successfully managed under CA systems in several countries such as Malaysia [54]. In India, the area under CA rice–wheat and rice–maize cropping systems has significantly increased during the last 10 years or so [10,55,56].

North America

CA adoption is the highest in the North-Western Parts of North America and in the southern parts of South America with adoption levels above 50%. Since 2008/09, the area under CA in the North America region has changed by 57.9% from 40.0 M ha to 63.2 M ha in 2015/16 (Table 3).

In Canada, CA is estimated to be practised on 19.9 M ha in 2015/16. This long-term and wide adoption of CA, mostly in the western provinces, has resulted in visible environmental benefits, including the absence of dust storms and a greater biodiversity [25,26].

Table 3. Extent of CA adoption ('000 ha) in North America in 2008/09, 2013/14 and 2015/16.

Country	CA area 2008/09	CA area 2013/14	CA area 2015/16
USA	26,500.00	35,613.00	43,204.00
Canada	13,481.00	18,313.00	19,936.00
Mexico	22.80	41.00	41.00#
Total	**40,003.80**	**53,967.00**	**63,181.00**
% difference		**34.9 since 2008/09**	**57.9 since 2008/09** **17.1 since 2015/16**

#from 2013/14.

Environmental services provided through CA are increasingly recognised, for example, through carbon payment schemes as in Alberta [57].

In the USA, CA adoption in 2008/09 was 26.5 M ha (21.5% of cropland) and in 2015/16, it was 43.2 M ha (35.1% of cropland), despite long-time experience with no-till farming. Although in the USA, no-till is still mostly applied for certain crops or as rotational practice, the awareness about crop rotations and cover crops as well as the additional benefits of permanent no-till systems is growing because of organised farmers' associations at the state level, and at the regional level, e.g. the Conservation Agriculture Systems Alliance (CASA). A particularly exciting development in no-till system in the USA is the practice of 'planting green'. This is establishing a crop, following a cover crop, without using any herbicides by using rollercrimper to subdue the cover crop [58,59]. In the USA, much of CA cropping has used maize, soybean and canola crops, but more recently cotton systems also.

South America

Table 4 shows information on CA adoption in South America. The adoption levels of CA farming in Argentina, Paraguay, Uruguay and Southern Brazil are approaching 100%. Since 2008/09, the area under CA in the South America region has changed by some 41% from 49.6 M ha to 69.9 M ha in 2015/16. But there are serious concerns about the quality of some of the CA adoption. Following market pressures, which are partly increased by government policies, a considerable number of farmers are opting for soya mono-cropping, even without any cover crops between two soya crops. This

Table 4. Extent of CA adoption ('000 ha) in South America in 2008/09, 2013/14 and 2015/16.

Country	CA area 2008/09	CA area 2013/14	CA area 2015/16
Brazil	25,502.00	31,811.00	32,000.00
Argentina	19,719.00	29,181.00	31,028.00
Paraguay	2400.00	3000. 00	3000.00
Uruguay	655.10	1072.00	1260.00
Bolivia	706.00	706.00*	2000.00
Venezuela	300.00	300.00*	300.00#
Chile	180.00	180.00*	180.00#
Colombia	102.00	127.00	127.00#
Total	**49,564.10**	**66,377.00**	**69,895.00**
% difference		**33.9 since 2008/09**	**41.0 since 2008/09** **5.3 since 2015/16**

*from 2008/09; #from 2013/14.

approach, despite applying the no-till practice, has the bad results of erosion and soil degradation. Accordingly, the area under good-quality CA could be argued to be, particularly in Argentina, Uruguay and Brazil, significantly lower than the total area under no-till cropping. The problem is being solved in Brazil with strengthened extension and in Uruguay with legal regulations for cover crops in the specific case of soya and subsidy programmes for goodquality CA. The problem has also been reported and is being solved in the recent no-till adoption report for Argentina, where recent policy changes have again opened up the opportunities for farmers to grow crops other than soya [60].

Europe

Since 2008/09, the CA area for annual crops in Europe has changed from 1.6 M ha to 2.0 M ha in 2013/14, and increase of 30%, and to 3.5 M ha in 2015/16, an increase of 127.4% (Table 5). In 2008/09, CA was reported in 11 countries but in 2013/14, this increased to 15 countries, and in 2015/16 to 29 countries. Since 1999, ECAF and its national association members, comprising many farmers, have been promoting CA systems in Europe, with significant adoption in Spain, Italy, Finland, France, Romania,

Table 5. Extent of CA adoption ('000 ha) in Europe in 2008/09, 2013/14 and 2015/16.

Country	CA area 2008/09	CA area 2013/14	CA area 2015/16
Spain	650.00	792.00	900.00
Italy	80.00	380.00	283.92
Finland	200.00	200.00	200.00
France	200.00	200.00*	300.00
Germany	354.00	200.00	146.00
United Kingdom	25.00	150.00	362.00
Slovakia	10.00	35.00	35.00#
Portugal	28.00	32.00	32.00#
Switzerland	9.00	17.00	17.00#
Hungary	8.00	5.00	5.00
Ireland	0.10	0.20	0.20
Moldova	–	40.00	60.00
Greece	–	24.00	24.00#
Netherlands	–	0.50	7.35
Belgium	–	0.27	0.27
Romania	–	–	583.82
Poland	–	–	403.18
Estonia	–	–	42.14
Czech Republic	–	–	40.82
Austria	–	–	28.33
Lithuania	–	–	19.28
Croatia	–	–	18.54
Bulgaria	–	–	16.50
Sweden	–	–	15.82
Latvia	–	–	11.34
Denmark	–	–	2.50
Slovenia	–	–	2.48
Luxemburg	–	–	0.44
Cyprus	–	–	0.27
Total	**1564.10**	**2035.97**	**3557.20**
% difference		**30.1 since 2008/09**	**127.4 since 2008/09** **74.7 since 2015/16**

*from 2008/09; #from 2013/14.

Poland, UK, Switzerland and Germany. They have brought CA to the notice of the European Commission as well as the European Parliament. Integrating CA principles and practices as part of CAP support to European farmers has been slow. Recently, there has been revived interest in supporting practices that would improve soil health management. Another positive help to strengthen the role of CA is the availability of improved no-till drills and other equipment manufactured in Europe, including the UK. The British efforts are remarkable. Farmers and machine companies have organised on-farm events to demonstrate no-till drills and participate in on-farm conferences to discuss their experiences and successes with CA practices, thus focusing issues of agro-ecological concern and offering ideas of climate-smart regenerative agriculture to build soil health, reduce input costs, and raise productivity and profit. For example, there is the annual Groundswell No-Till Show and Conference, at which some dozen machine companies demonstrate their CA no-till drills and farmers and CA experts from the UK and abroad make presentations on different topics related to regenerative and sustainable agriculture based on CA principles and practices.

Russia and Ukraine also show significant adoption of CA and they also have active farmer groups promoting CA. In Russia, the area under reduced tillage is believed to be some 15 M ha, but CA according to FAO definition is estimated to be about 5.0 M ha. In Ukraine, CA has reached some 700,000 ha in 2013/14, but an accurate estimate of CA area was not possible in 2015/16.

Asia

Asian countries have adopted CA in many areas during the past 10–15 years, and since 2008/09, CA area has increased more than fourfold (429.7%), from some 2.6 M ha in 2008/09 to some 13.9 M ha in 2015/16 (Table 6). In 2008/09, CA area was reported in

Table 6. Extent of CA adoption ('000 ha) in Asia in 2008/09, 2013/14 and 2015/16.

Country	CA area 2008/09	CA area 2013/14	CA area 2015/16
China	1,330.00	6,670.00	9,000.00
Kazakhstan	1,300.00	2,000.00	2,500.00
India	–	1,500.00	1,500.00#
Kyrgyzstan	–	0.70	50.00
Turkey	–	45.00	45.00
Syria	–	30.00	30.00#
Korea, DPR	–	23.00	23.00#
Iraq	–	15.00	15.00#
Uzbekistan	–	2.45	10.00
Azerbaijan	–	1.30	1.30#
Lebanon	–	1.20	1.20#
Pakistan	–	–	600.00
Iran	–	–	150.00
Bangladesh	–	–	1.50
Tajikistan	–	–	1.20
Vietnam	–	–	1.00
Cambodia	–	–	0.50
Laos	–	–	0.50
Total	**2630.00**	**10,288.65**	**13,930.20**
% difference		**291.2 since 2008/09**	**429.7 since 2008/09 35.4 since 2013/14**

#from 2013/14.

only two countries in the Asia region, but in 2013/14 CA area was reported in 11 countries and in 2015/16 in 18 countries. In Central Asia, a faster development of CA can be observed in the last 10 years in Kazakhstan which now has 10.5 M ha under reduced tillage, mostly in the northern drier provinces, and of this some 2.5 M ha (15.6% of crop area) are 'real' CA with permanent no-till and rotation. Kazakhstan is amongst the top 10 countries in the world with the largest crop area under CA systems. In addition, Uzbekistan, Azerbaijan, Kyrgyzstan and Tajikistan, as well as Laos, Vietnam and Cambodia have made a committed start to promoting rain-fed and irrigated CA cropping systems [50,61,62], and so have other countries in West Asia such as Iran, Turkey, Lebanon, Syria and Iraq [63,64]. Iran and Turkey now report some 150,000 ha and 45,000 ha under CA, respectively. Area under CA in Syria and Iraq has continued to increase because of shortages of fuel [65], but no current figures are available.

In the wheat–rice cropping systems of the Indo-Gangetic Plains across India, Pakistan, Nepal and Bangladesh, large adoption of no-till wheat with some 5 M ha is reported, but only modest adoption of permanent no-till systems and full CA [10]. The exception appears to be India and Pakistan, where significant adoption (1.5 and 0.6 M ha, respectively) of no-till practices by farmers has occurred in recent years in the rice–wheat double cropping system [10], and also in the rain-fed upland areas in India for crops such as maize, sorghum, millets, cotton, pigeon pea and chickpea. Bangladesh has begun to report some CA area with rice-based system, particularly on permanent beds. This is expected to expand because farmers can now access no-till seeding service from service providers when locally produced CA equipment is available.

China has been experiencing an equally dynamic development of CA. It began over 20 years ago with research, and then the adoption of CA increased during the last few years and the technology has been extended to rice production. In 2013/14, some 6.7 M ha were under CA in China and 23,000 ha in DPR Korea were reported. For 2015/16, China reports CA area of some 9.0 M ha [49]. The introduction of CA has made it possible to grow two successive crops (rice, maize or soya as summer crop, and wheat or barley as winter crop) within the same year, through direct drilling of the second crop into the stubble of the first.

West Asia and North Africa

Research and practical field demonstrations in the West Asia and North Africa (WANA) winter rainfall Mediterranean region has shown that yields and factor productivities can be improved with no-till systems [63,65–68]. Extensive research and development work has been conducted in several countries in the region since the early 1980s [8,9] such as in Morocco, Tunisia, Algeria, Syria, Iraq, Lebanon, Jordan, Turkey and Iran (Table 7). Since 2008/09, the area under CA has increased substantially – from 10,000 ha to 103,200 ha in 2013/14, and to 269,300 ha in 2015/16, an increase of some 269%. In 2008/09, only two countries reported the existence of CA area, but in 2013/14 the number increased to six countries, and in 2015/16, it was eight countries.

Morocco, Tunisia and Algeria have shown a modest growth in CA adoption, but the adoption has been enormous in Iran and Syria, increasing in only a few years to

Table 7. Extent of CA adoption ('000 ha) in the WANA region in 2008/09, 2013/14 and 2015/16.

Country	CA area 2008/09	CA area 2013/14	CA area 2015/16
Tunisia	6.00	8.00	12.00
Morocco	4.00	4.00	10.50
Turkey	–	45.00	45.00
Syria	–	30.00	30.00#
Iraq	–	15.00	15.00#
Lebanon	–	1.20	1.20#
Iran	–	–	150.00
Algeria	–	–	5.60
Total	**10.00**	**103.20**	**269.30**
% difference		**932.0 since 2008/09**	**259.3 since 2008/09** **160.9 since 2013/14**

#from 2013/14.

150,000 ha and 30,000 ha, respectively. Iran is the largest adopter in the region followed by Turkey (45,000 ha) and Syria as the second and third largest CA adopters, respectively. Iraq too now has some 15,000 ha of CA, benefitting from the work done by ICARDA in Syria, Iraq and elsewhere [65]. The main reason for the rapid uptake is the increased availability of locally produced affordable no-till seeders in Syria, Iran and Turkey, which are also being exported elsewhere in the WANA region, and the efforts of development and promotion activities by organisation such as GIZ, ICARDA, FAO and Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD) as well as bodies such as INRA in Morocco, American University in Beirut, Aga Khan Foundation in Syria and Réseau Innovations Agro-Systèmes Méditerranéens (RCM) across the WANA Mediterranean region. At the Climate Summit COP 22 in Marrakesh, the Moroccan government proposed the 'Triple A' programme for Africa (Adaptability of African Agriculture to Climate Change) which was accepted. The Moroccan government also set for itself a target of 5 M ha of land under conventional tillage agriculture to be transformed to CA systems over the next 10 years. Thus, the 'Triple A' initiative and the decision taken by Morocco to adopt CA are likely to help African farmers and governments to accelerate the spread of CA across Africa.

International experiences about CA and considerations for its implementation in the Mediterranean region show the potential benefits that can be harnessed by farmers in the semi-arid Mediterranean environments, and highlight the need for longer term research including on weed management, crop nutrition, crop-livestock integration, biomass management and economics of CA systems. Some of the crop-livestock integration issues such as biomass management need to be resolved at the community level because post-harvest crop biomass are in demand by livestock herders and the traditional arrangement between crop farmers and herders is not conducive to CA development [66,69]. Besides, unless farmers are engaged through an enabling policy with institutional support and the opportunity to learn CA practices and how to integrate them into crop-livestock production system, rapid uptake of CA is not likely to occur. Examples exist for the technical feasibility of successful crop-livestock integration in such environments. But since the traditions and community structures are country specific, only locally developed procedures for introduction and adoption of CA systems will be successful in the long term.

Work by ICARDA and CIMMYT in the WANA region has shown benefits of CA by the increase in crop yields, soil organic matter, water use efficiency and net revenue. CA also shows the importance of using cropping and crop diversification with legumes and cover crops, instead of a fallow period, leading to improved productivity, soil quality, N-fertiliser use efficiency and water-use efficiency. In dry areas, CA allows farmers to improve their productivity and profitability while conserving and even improving the natural resource base and the environment. Yet although CA works better than tillage-based farming, the adaptation in drylands is affected by water scarcity and drought hazard, low biomass production and acute competition between conflicting uses including soil cover, animal fodder, cooking/ heating fuel, and raw material for habitat. Many WANA smallholders are poor and rely more on livestock than on grain production.

Africa

In Africa, innovative participatory approaches are being used to develop supply chains for smallholders to access CA equipment. Similarly, participatory learning approaches such as those based on the principles of farmer field schools and lead-farmer networks are being encouraged to explain the ecological principles underlying CA and to make it attractive for use in local farming.

CA is spreading in eastern and southern Africa, and North Africa (Table 8), using indigenous and scientific knowledge, and equipment design from Latin America. There is now also collaboration with China, Bangladesh and Australia, and CIMMYT, ICARDA, ICRISAT, ICRAF, CIRAD, ACT, FAO, IFAD, AfDB and NGOs. These have all stimulated the trend to have local practices and local equipment, with advantages in maintenance and repair. Farmers in at least 22 African countries are promoting

Table 8. Extent of CA adoption ('000 ha) in Africa in 2008/09, 2013/14 and 2015/16.

Country	CA area 2008/09	CA area 2013/14	CA area 2015/16
South Africa	368.00	368.00*	439.00
Zambia	40.00	200.00	316.00
Kenya	33.10	33.10*	33.10#
Zimbabwe	15.00	90.00	100.00
Sudan	10.00	10.00*	10.00#
Mozambique	9.00	152.00	289.00
Tunisia	6.00	8.00	12.00
Morocco	4.00	4.00	10.50
Lesotho	0.13	2.00	2.00
Malawi	–	65.00	211.00
Ghana	–	30.00	30.00#
Tanzania	–	25.00	32.60
Madagascar	–	6.00	9.00
Namibia	–	0.34	0.34#
Uganda	–	–	7.80
Algeria	–	–	5.60
Swaziland	–	–	1.30
Total	**485.23**	**1235.34**	**1509.24**
% difference		**154.6 since 2008/09**	**211.0 since 2008/09 22.2 since 2013/14**

*From 2008/09; # from 2013/14.

CA (Kenya, Uganda, Tanzania, Rwanda, Sudan, Ethiopia, Swaziland, Lesotho, Malawi, Madagascar, Mozambique, South Africa, Namibia, Zambia, Zimbabwe, Ghana, Burkina Faso, Senegal, Cameroon, Morocco, Tunisia and Algeria). CA has also been incorporated into the regional agricultural policies by NEPAD, and it is recognised as a core element of climate-smart agriculture [8]

CA systems help Africa's resource-poor farmers to maintain subsistence with sustainability, so as to meet the challenges of climate change, high-energy costs, environmental degradation and labour shortages. The CA area is still relatively small, mainly because of the small land holdings as well as greater attention being paid to the promotion of conventional tillage agriculture, without much success. But there is a developing trend, a CA movement of some two million small-scale farmers on the continent. These farmers cover, along with medium- and large-scale farmers, a total CA area of some 1.5 M ha in 2015/16. Since 2008/09, CA has spread further (details lacking) in countries such as Kenya, Madagascar, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe. Currently, South Africa is undertaking a national consultation process to facilitate the integration of CA into national agricultural development policy. Similarly, AfDB has announced that it will promote agricultural development in the Guinea Savanna zone of Africa based on CA systems.

In 2008/09, CA was reported in nine countries, but in 2013/14 there were 14 countries with area under CA and in 2015/16, 17 countries. The total area of CA in Africa in 2015/16 is more than 1.5 M ha, an expansion of some 211% since 2008/09, from 0.48 M ha. From expert knowledge expressed at the First Africa Congress on Conservation Agriculture in March 2014, CA is expected to increase food production with fewer negative effects on the environment and energy costs, and to result in the development of locally adapted technologies consistent with CA principles [8].

Concluding remarks

CA is a new paradigm for farming worldwide. It changes the production system and agricultural land management thinking. Originally, the adoption of CA was mainly prompted by acute problems faced by farmers, especially wind and water erosion, as, for example, southern Brazil or the Prairies in North America, or drought in Australia. In all these cases, the farmers' organisation generated knowledge that eventually led to mobilising public, private and civil sector support. More recently, again pressed by erosion and drought problems coming with climate change, exacerbated by increase in cost of energy and production inputs, government support has accelerated the adoption rate of CA in Kazakhstan, China, India and Pakistan but also in some African countries such as Zambia, Zimbabwe, Malawi and Mozambique among others, and this is attracting support from other stakeholders. In Europe too, there has been greater concern shown by the EU towards soil degradation and the need for greater environmental and soil health management in agriculture. Thus, by means of the Common Agricultural Policy, Member States of the EU have been able to provide incentives to farmers to adopt soil and water conservation practices that are also climate-smart.

The main reasons for adoption of CA can be summarised as follows: (1) better farm economy (reduction of production inputs of seeds, fertiliser, pesticides and water, and lower costs in machinery and fuel, and time-saving in the operations that permit the development of other agricultural and non-agricultural complementary activities); (2) flexible technical possibilities for sowing, fertiliser application and weed control (allowing for more timely operations); (3) equal yields or yield increases (depending on the starting level of soil degradation), greater yield stability (as long-term effect) and higher overall seasonal production; (4) soil protection against water and wind erosion; (5) greater nutrient use efficiency and retention; (6) fewer crop protection problems and costs; and (7) better water-use efficiency and retention, and better water economy including in dryland areas.

In result, farmers have higher profits. Otherwise, they would not be practising CA on more than 180 M ha of cropland globally, nor would it be spreading at an annual rate of more than 10 M ha. No-till and cover crops are used between rows of perennial crops such as olives, nuts and grapes or fruit orchards, and in plantation systems. CA can be used for winter crops, for traditional rotations with legumes, sunflower and canola and in field crops under irrigation where CA can help optimise irrigation system management to conserve water, energy and soil quality, reduce salinity problems and to make fertiliser use more efficient.

At the landscape level, CA enables several environmental services to be harnessed at a larger scale, particularly C sequestration, cleaner water resources, drastically reduced erosion and runoff, and with this, flooding, as well as enhanced biodiversity. Overall, CA as an alternative paradigm for sustainable production offers many benefits to producers, the economy, consumers and the environment that cannot be obtained from tillage agriculture. With CA, production becomes a matter of output rather than inputs. So, CA is not only climate-smart, but smart in many other ways.

Globally, the total CA area is still relatively small compared to the total arable areas using tillage. Yet this is changing, and the spread of CA worldwide appears to have been expanding at the rate of 10.5 M ha per annum since 2008/09. It is expected that large areas of agricultural land in Asia, Africa, Europe and Central America will increasingly be transformed by CA in the coming decades as can already be seen in Kazakhstan, India, Pakistan, China, South Africa, Zimbabwe, Zambia, Malawi, Morocco, Spain, Italy, France and the UK. This is because in the last two decades, the adoption of CA has been important to farmers themselves, to governments, donor agencies, international technical assistance agencies, NGOs and Foundations, and service sectors. In some countries such as the USA, Canada, Australia, Brazil, Argentina, Paraguay and Uruguay, it appears that CA is being 'mainstreamed' in agricultural development programmes. But only a few countries such as Canada, Switzerland, Italy, Spain, Kazakhstan, China, Zambia, Zimbabwe, Mozambique, Malawi, South Africa and more recently Cuba *emphasize* its importance. This will change. CA is the future of sustainable agriculture.

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