Driving Forces and Constraints Opportunities for Further Development of CA

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Drivers & Constraints

- **Drivers**: Factors that facilitate the development and use of CA.

- **Constraints**: Factors that tend to discourage or inhibit CA use.

Drivers Act at:

- farmers level;
- institutional level;
- social level;
- policy level.

Drivers

Farmers drivers Acts of CA:

Why farmers adopt innovation:

- to increase farm technological level;
- to increase near-term profitability;
- to reduce risks;
- to reduce effort - drudgery! (Important factor usually neglected by developers).

Farm Level

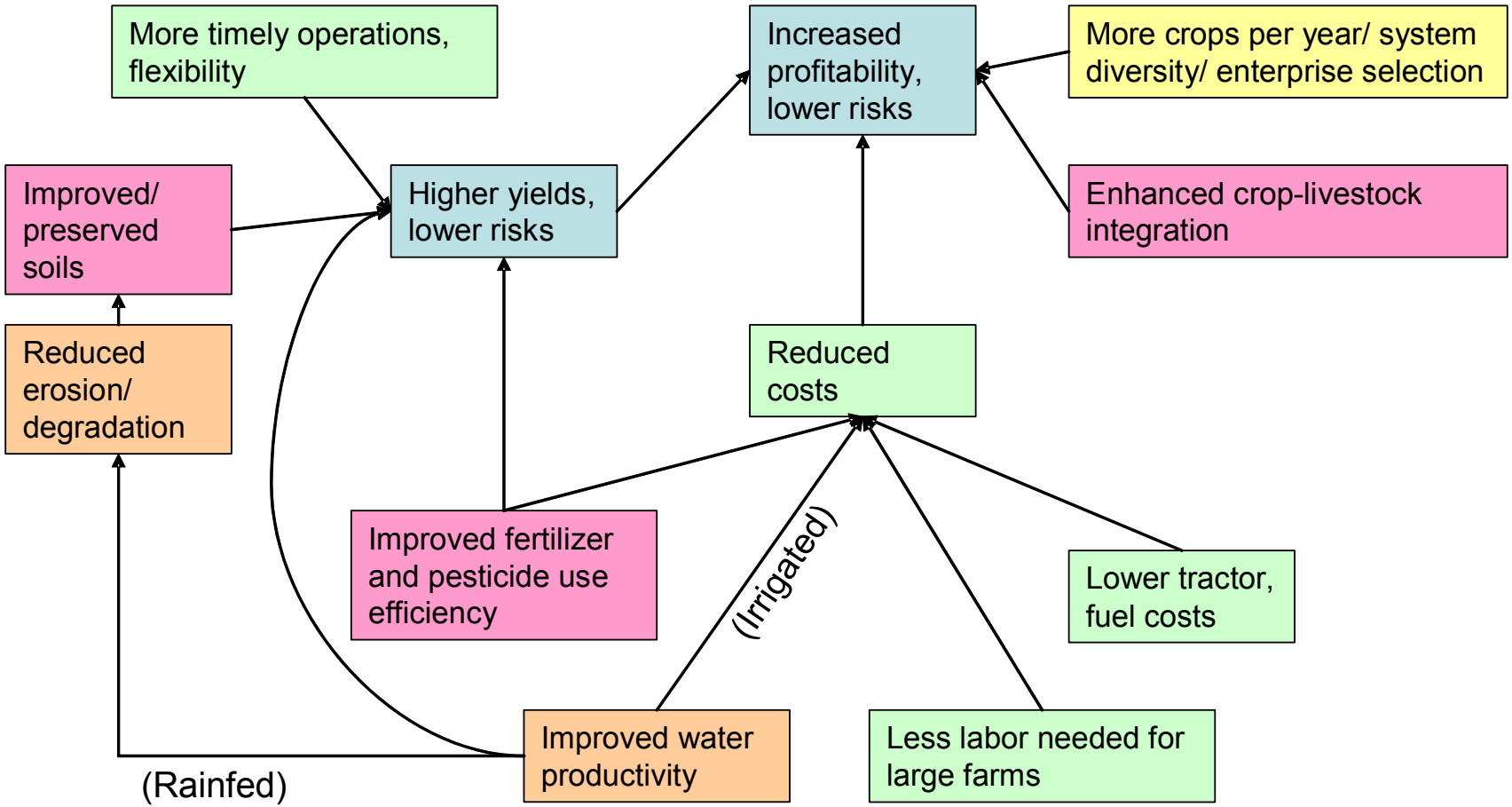

Figure 2. Drivers of conservation agriculture – farm level

Farm Level

Drivers	Agroecosystems	Perception
Reduces costs	Nordic/North European	The most important driving forces to CA
	Mediterranean Region	Initiate for the necessity of reducing different inputs
	The indo-Gangetic Plains	Wheat after rice result in saving cost
	Asia	•The practice reduces fossil fuel consumption and tractor parts and accessories replacements
	South Brazil and Bolivia	•Saving machinery and labor costs

•Agroecosystems as cost savings were not mentioned

Farm Level

Drivers	Agroecosystems	Perception
Reduces soil erosion and soil degradation	Sloping Land in southern Brazil	•"...depending on the soil type ... mechanical measures were not effective, the production of annual crops was not recommended and supported by official institutions (research, extension and credit) in such erosion-prone areas. Such situation lead farmers to search for other alternatives, and CA were disseminated...".
	Mediterranean Region	•"... one of the driving forces for evolution of CA has been the necessity of controlling erosion by rainfall – runoff and wind".

Farm Level

Drivers	Agroecosystems	Perception
Reduces soil erosion and soil degradation	European and slopping hillside systems of Vietnam	Soil erosion and land degradation were also mentioned as important potential drivers of conservation agriculture (water and wind erosion, soil crusting, pebble-raising).
	Indo-Gangetic Plains	Land degradation with the form of soil fertility and groundwater depletion, and salinization or waterlogging of fields, more than erosion as such.

Farm Level

Drivers	Agroecosystems	Perception
Improved water productivity	Mediterranean	"... much better water economy and efficient water use through a higher accumulation and infiltration of water in the soil profile and lower water losses by evaporation and runoff. This is especially well appreciated by dry-land farmers in areas where the water available for crop growth becomes a limiting factor in dry years."
	Indo-Gangetic Plains	Water productivity and management, and their effects on crop yields, were found to be important in rice-wheat systems.

Farm Level

Drivers	Agroecosystems	Perception
Improved water productivity	Other Regions	Waterlogging and salinization reduce yields in some places, while groundwater depletion threatens the very existence of irrigated agriculture in others. The use of no-till, bed and furrow systems, laser leveling and other resource conserving practices have proven their usefulness in improving water management. Improvements in the timeliness of sowing (made possible by no-till and similar practices) can also result in improved water productivity.

Farm Level

Drivers	Agroecosystems	Perception
Improved water productivity	Cerrados of Brazil	There is reason to believe that the conservation of soil moisture through conservation agriculture practices allowed the introduction of double-cropping where monocropping had been the rule.

Farm Level

Drivers	Agroecosystems	Perception
More flexibility and improved timeliness of operations	Indo-Gangetic Plains	The original motivation for developing no till wheat technology.
	Bolivia	No till was describe as allowing earlier sowing, resulting in higher yields.
	Mediterranean	“CA can offer large possibilities, particularly no-tillage systems, as flexible and early times for sowing, fertilizer application and weed control ... yield increase (10% to 15% higher) ... greater yield stability ... faster crop establishment and ...”

Farm Level

Drivers	Agroecosystems	Perception
Diversification and enterprise selection	Indo-Gangetic Plains	Timeliness of sowing is often closely linked to system intensification, diversification, and enterprise selection.
	Asia	There is an expectation that no-till could be used in sloping upland systems in Vietnam for sowing a second crop after upland rice or maize.
	Southern Brazil	Sustainable multiple-cropping was only made possible by the use of mulch-based soil cover.

The most dramatic example of conservation agriculture fostering changes in enterprise selection, comes from the Cerrados of Brazil, where a successful transition was made from full-till monocropping to no-till conservation agriculture multiple-cropping.

Farm Level Summary

Summary

Table 4. Farm-level drivers of the development and adoption of conservation agriculture, by climate and agroecosystem (Darker shades indicate drivers of greater importance. Blank cells indicate low levels of importance or lack of information).

	Temperate	Mediterranean		Tropical			Subtropical irrigated		Subtropical rainfed	
Drivers	Agro-ecosystems in temperate northern Europe	Water-scarce rainfed agro-ecosystems in the Mediterranean	Irrigated, intensive systems, including fruit trees	Wheat-soybean and related systems in lowland tropical Bolivia	Crop – pasture systems in the Cerrados of Brazil	Irrigated horticultural systems in eastern Brazil	Rice-wheat and related systems in the Indo-Gangetic Plains	Intensive rice-based systems in the river valleys of northern Vietnam	Multiple-cropping in high-rainfall environments in southern Brazil and central Argentina	Sloping land systems on hillsides in northern Vietnam
Reduced costs										
▪ Lower tractor, fuel costs										
▪ Lower labor costs										
Increased yields										
▪ Reduced resource degradation	Water and wind erosion	Water and wind erosion					Salinization, groundwater depletion, reduced soil fertility		Water erosion	Water erosion
▪ Water infiltration/ savings										
▪ Timeliness of sowing										
Enterprise selection										
▪ More crops per year/ diversity, flexibility										

Farm Level Summary

Appendix 1

Synthesis of major driving forces regarding shifting from conventional agriculture to Conservation Agriculture (CA)

MEDITERRANEAN PLATFORM	EUROPEAN PLATFORM	LATIN AMERICAN PLATFORM	ASIAN PLATFORM
Better economy at farm level	Soil erosion	Better economy (savings on machinery, labour and drudgery)	Institutional factors (public and private sectors).
More flexible technical possibilities (sowing, fertiliser application, weed control, etc.)	Soil crusting	Institutional factors (public and private sectors)	Population pressure
Greater water economy in dryland areas	Pebble raising	Technical facilities (machinery, agrochemicals) (Brazil, Argentina)	Better economy (savings on machinery, labour and drudgery)
Soil protection	Increase OM necessity	More flexible technical possibilities (e.g. sowing) (Bolivia)	Livelihood improvement (by increasing yields, crop diversification, timely planting for the rice-wheat system)
Cropping diversification	Higher trafficability	Soil erosion (Brazil, Argentina) and fertility and yield (Brazil)	Improvement in environmental quality (land and water resources)
Yield increase and stability	Development of technologies (machinery and herbicides)	Crop x livestock integration (Brazil)	Availability of adapted machinery
Greater nutrient-use efficiency (less use of fertilisers)	Improvement of labour organisation		Herbicide resistance in weeds
	Farmer associations promoting CA		
	Costs and labour time reduction		
	Yield increase/stabilisation		
	Political decisions that indirectly favour CA		
	Regulation measures (reduction of environmental impacts)		
	Subsidies		

Institutional and social drivers of CA:

- the dynamism and effectiveness of innovation systems in generating knowledge to adapt and improve conservation agriculture practices;

- the extent to which conservation agriculture implements and technical services are generally available to farmers;

- the leading role of farmers and farmer organizations in the transformation from conventional to conservation agriculture; and

- the occurrence of a “crisis”, resulting in a more rapid development of conservation agriculture practices and implements.

Institutional & Social

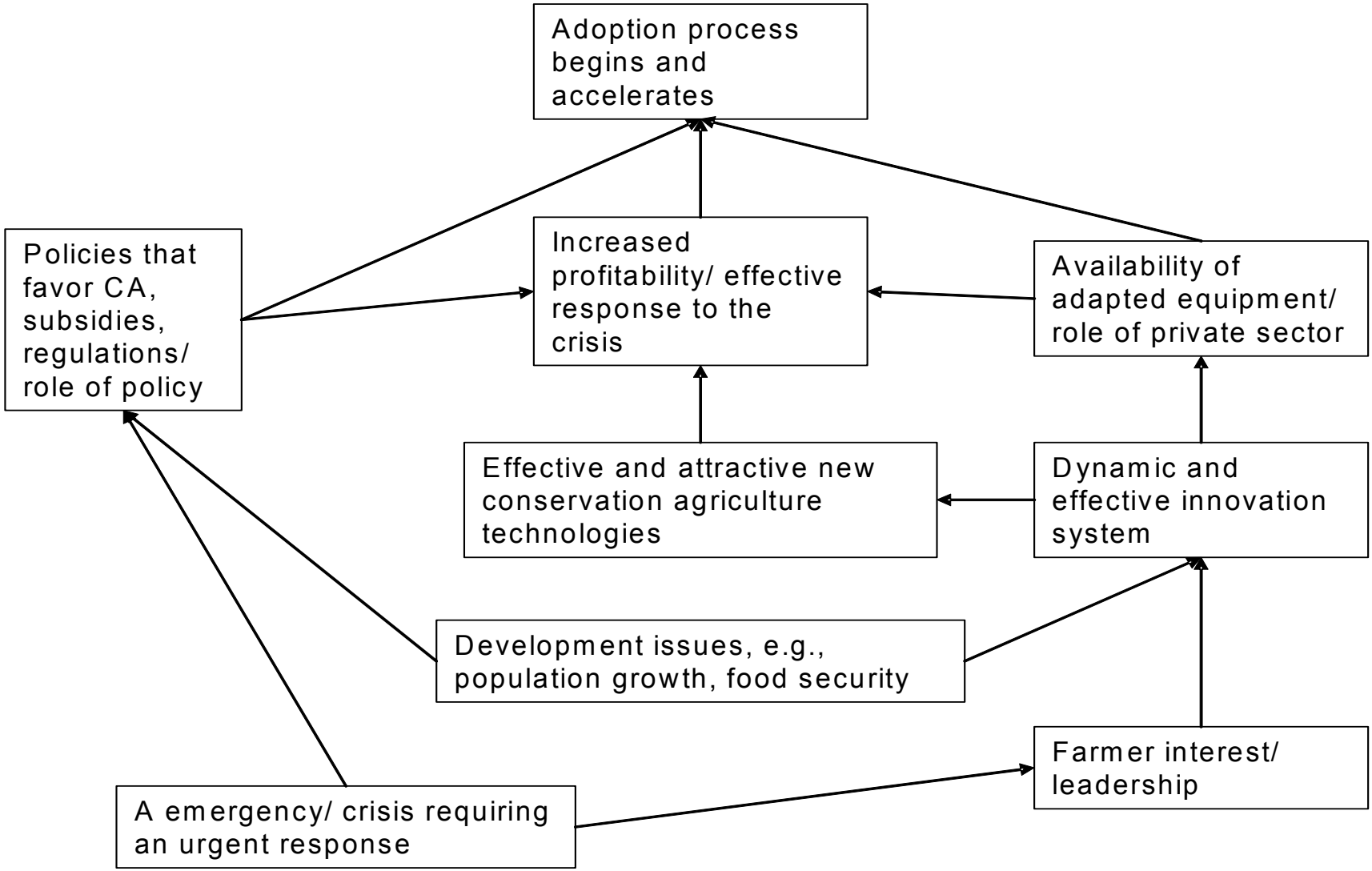

Figure 3. Drivers of conservation agriculture – policy, institutional and social levels

Institutional & Social

Drivers	Agroecosystems	Perception
Dynamic and effective innovation systems	Latin American and Asian Platform	The formation of CA farmers' associations has furthered the dialogue between industry and farmers, as well as advancing adoption of CA by helping farmers overcome some of the hurdles associated with obtaining information or even funds for CA implements.

Knowledge generation is most effective when embedded in an innovation system that is dynamic and inclusive, one that brings in relevant stakeholders and is quick to learn. At its best, an innovation system will co-evolve with the technologies being developed – new partners will come on board as new problems are encountered or new needs are identified.

Institutional & Social

Drivers	Agroecosystems	Perception
Ready availability of conservation agriculture implements	Over all	Ready availability of adapted implements for conservation agriculture, especially drills for direct-sowing into soil cover, is an important driver of the transition from conventional to conservation agriculture.
	Vietnam	Farmers cannot experiment with no-till direct-sowing if they have no access to implements capable of performing this operation. Note that the availability of implements may be less of an issue in systems that are less mechanized.

Institutional & Social

Drivers	Agroecosystems	Perception
Leadership from farmers and farmer organizations	Latin America	Individual farmers or farmer organization were responsible for "driving" – the development and dissemination of CA practices. NGOs, international and national public sector research institutions, universities and others, gradually come on board and made their significant contributions.
	Indo-Gangetic Plains	Farmers did not lead the transition to not-till although they did make essential contributions.

Institutional & Social

Drivers	Agroecosystems	Perception
The presence or a crisis mentality	Over all	"In essence, what appears to be necessary to foment widespread CA adoption is a combination of very real and acute problems to trigger real responses, proactive and dynamic farmers with sufficient knowledge and resources, and good linkage between industry, farmers and research..." "... the constraints to CA extension are often stronger than driving forces, except if there is a crisis regarding soil fertility (e.g.: hugely degraded soils, intense erosion, non availability of water resource, …) or regarding labor requirement..."

Institutional & Social

Drivers	Agroecosystems	Perception
The presence or a crisis mentality	Southern Brazil	The conversion of pasture land in southern Brazil to annual cropping, and the resulting crisis of soil erosion, provided a sense of urgency that drove stakeholders to take swift and effective action.
	Indo-Gangetic Plains	The herbicide-tolerant weeds in wheat was the motivation for launching an emergency program of farmer experimentation with no-till – with spectacular results.

It is not clear, however, the extent to which a sense of crisis led to more rapid progress in Argentina, the Cerrados of Brazil, or the lowland tropics of Bolivia.

Crisis of labor and drudgery perception.

Policy drivers of CA:

The KASSA platform teams uncovered a host of policy issues that, under the right circumstances, can foster the development and use conservation agriculture.

Understandably, different platforms emphasized different policy questions. In most instances, the policies in question are capable of either driving or constraining the use of conservation agriculture – according to how they are shaped and the incentives they create.

Policy Drivers

Drivers	Agroecosystems	Perception
Favorable Macroeconomic policies	Latin America	Negative effect of national fiscal and monetary policies on the profitability of agricultural production. Some policies have depressed product prices, raised interest rates, restricted the availability of credit, and discouraged investment. It might be further observed, however, that when conservation agriculture has a strong cost-savings element, a shift to these technologies might be one way that farmers can adapt to an unfavorable macroeconomic regime.

Policy Drivers

Drivers	Agroecosystems	Perception
Favorable Macroeconomic policies	Mediterranean and Asian platform	The goals of such policies usually include reducing poverty, fostering food and environmental security, enhancing natural resource conservation, and improving rural livelihoods. Given the potential of conservation agriculture to help achieve these goals, it was suggested that these policies be reshaped to explicitly support conservation agriculture research and development.

Policy Drivers

Drivers	Agroecosystems	Perception
Favorable Agricultural Sector Policies	Brazil	Recall that the erosion crisis in southern Brazil was initially sparked by a policy that encouraged the expansion of soybean and wheat production into areas previously devoted to cattle and coffee.
	South Asia	Some countries retain food security policies that provide input subsidies and price supports for food/grain production. These policies tend to encourage over-production of rice and wheat, reduce incentives for efficient input use, discourage the production of alternative crops and, sometimes, damage the resource base. Such policies can increase the difficulty of developing conservation agriculture technologies that are economically attractive to farmers.

Policy Drivers

Drivers	Agroecosystems	Perception
Favorable Agricultural Sector Policies	European Platform	There is a possibility of trade-offs between conflicting agricultural sector policies. For example, a policy aiming to mitigate soil erosion (achievable through conservation agriculture) might conflict with another policy discouraging the use of herbicides (often critical to the initial success of conservation agriculture practices). It is clear that in EU countries, the Common Agricultural Policy (CAP) can either foster or discourage a shift to conservation agriculture.

Policy Drivers

Drivers	Agroecosystems	Perception
Policies affecting farm size, agrarian structure and land tenure	European Platform - Countries from former soviet system	Policies and practices carried over from the soviet era can have noticeable impacts on agrarian structure, systems of land holding, farm size, and farmers' confidence and attitudes. These can encourage or discourage the adoption of conservation agriculture.
	East Europe	The European platform team called attention to differences in the size of holdings between East and West Germany, and land ownership differences between Scotland and England in the United Kingdom.

Policy Drivers

Drivers	Agroecosystems	Perception
Appropriate Agricultural Research Policies	Over All	As KASSA´s result, agricultural research and extension institutions will have the opportunity to play a stronger & more effective role in fostering the use of conservation agriculture. The introduction of conservation agriculture requires many adjustments in traditional agronomic and crop management practices that research can help identify. Equally important is for research to quantify and perhaps even forecast the long term agronomic, economic, social and environmental consequences of the widespread adoption of conservation agriculture practices.

Policy Drivers

Drivers | **Agroecosystems** | **Perception**

Appropriate Agricultural Research Policies

Lessons drawn for Latin American and Asian platforms suggest that research efficiency improves when close cooperation is achieved between research institutions and all other partners, in the context of a broader innovation system, using multidisciplinary approaches and systems thinking. To succeed in responding to this challenge, research institutions may need to scrutinize their internal research policies and priorities. Otherwise, research centers themselves may pose a constraint to the development and use of conservation agriculture.

Also, as suggested in the European platform report, close collaboration between research and extension workers, private sector implement manufacturers and farmers is needed for the development of no-till direct-sowing drills that are effective even when seeding into large amounts of loose residues, and no-till drills specifically designed for small scale farmers.

Policy Drivers

Drivers	Agroecosystems	Perception
Policies for training, communication and support for farmers´ initiatives	•Foster partnerships between private companies, public institutions and farmers. •Facilitate farmer access to and acquaintance with conservation agriculture technology, and farmer-to-farmer communication. •Support networking on conservation agriculture for knowledge development and sharing. •Promote participatory multiple-stakeholder conservation agriculture projects. •Develop institutional mechanisms to provide support for farmers' initiatives. •Promote conservation agriculture in educational programs. •Provide training in conservation agriculture for farmers – but also for extension workers, research managers, scientists, teachers, donors and policymakers. •Publicize the potential benefits of conservation agriculture to policymakers.	

Policy Drivers

Constraints	Agroecosystems	Perception
Agroclimatic Factors - Climate	North European	"Cold and wet sand and silt soil and heavy clay [are] difficult to cultivate without ploughing in a short season."
	Latin America - Argentina	CA was not really suitable for some temperate sub-humid and subtropical regions where "monozonic" rainfall patterns and "deficient" water balances limit biomass production, crop development and final yield. It contradict experiences from other parts of the world where CA is used to improve water productivity and agroecosystem profitability in water scarce environments.

Policy Drivers

Constraints	Agroecosystems	Perception
Agroclimatic Factors-Soil	European Platform	CA is most suitable for well-drained soils. "Reduced tillage methods are best suited to medium textured soil and well drained clay, and clay loam soils ... heavy clay and sandy and silty soils are not good opportunity for reduced/none tillage due to compaction and poor drainage ability." "Chernozems soils in Ukraine are ideal for CA, while solontzetic, overmoistened, gleyed, sandy and stony soils are regarded as not suited."

Policy Drivers

Constraints	Agroecosystems	Perception
Agroclimatic Factors-Soil	Latin America	"... more evident under soil moisture stress associated to high clay and low organic matter content or in soils with high silt content ..." and that "there is a need to evaluate to what extent farmers´ perception corresponds to real problems of soil compaction."
	Asian Platform	The whole issue of compaction is hugely complicated by the opposing edaphic requirements of two different commonly-grown crops (rice and wheat). Recall that rice culture continues to use puddling to maintain standing water on the soil surface for much of the crop growing period.

Policy Drivers

Constraints	Agroecosystems	Perception
Technology Management - Residues	Over all	The retention of crop residues for soil cover is a major component of CA. A scarcity of residues can hinder the introduction of CA technologies. Oddly enough, excessively high levels of residues can also serve as a constraint.

Residue scarcity emerges when biomass production is relatively low - or when the use of residues for mulch competes with their use for livestock fodder. Residue retention becomes exceptionally difficult when traditional land use systems allow open and unrestricted grazing of livestock on crop residues after grain harvest.

Policy Drivers

Constraints	Agroecosystems	Perception
Technology Management - Residues	Latin America	These problems may be found in many parts of Argentina, Bolivia and Brazil, where they especially affect small scale farmers.

When farmers in tropical climates produce only one crop per year, high rates of residue decomposition may leave soils uncovered for extended periods. This at times can be addressed through new rotational strategies or the introduction of adapted cover crops.

The introduction of conservation agriculture can also be constrained by excessive levels of residues. A surfeit of residues on the soil surface can make the establishment of following crops difficult to impossible, unless farmers have access to specialized no-till direct-sowing drills that can cope with high residue volumes.

Policy Drivers

Constraints	Agroecosystems	Perception
Technology Management - Residues	Northern Europe and Indo-Gangetic Plains	Where many farmers deal with large volumes of loose straw by simply burning it. Retention of rice straw on the soil surface tends (in the absence of specialized drills) to hinder the timely sowing of the following wheat crop. Incorporating the straw tends to immobilize soil nitrogen, requiring that farmers apply additional nitrogenous fertilizers if they are to avoid a yield penalty.

Finally, when residue retention and no-till result in cooler soil temperatures and delayed sowing (as in northern Europe), yields may be depressed and farm income reduced.

Policy Drivers

Constraints	Agroecosystems	Perception
Technology Management - Cover crops	Mediterranean Platform	Cover crops were described as being used between rows of perennial crops such as olives, nuts and grapes…
	Asian Platform Northem Vietnam	Substantial work done in hillside agroecosystems on “living mulch” (green manure cover crops grown together with the main crop in order to maintain soil cover) and “in-situ mulch” (cover crops grown, then knocked down by herbicide or mechanically so that the main crop may be sown into fresh residue).

Policy Drivers

Constraints	Agroecosystems	Perception
Technology Management - Cover crops	European Platform	There have been many experiments on cover crop management within various crop rotations, including winter and summer catch crops, intercrops and under-sown crops. However, at present, few farmers are said to use cover crops within market crop rotations, largely because they increase production costs and they are not marketable.

The introduction of cover crops can discourage farmer use of CA when (1) they increase production costs without generating commensurate benefits, or (2) when inappropriate cover crops are chosen for specific climatic zones or agro ecosystems.

Policy Drivers

Constraints	Agroecosystems	Perception
Technology Management - Rotations	Brazil & European & Indo-Gangetic Platform	Plays an important role in strategies for integrated weed, pest and disease management. Frequently, however, the use of rotations for these purposes is ruled out by farm-level economics. Desirable rotation crops are often simply unprofitable because of lack of markets and low product prices.
Weeds, pests and diseases	Mediterran & Latin America & European Platform Teams	Farmer use of CA practices is sometimes constrained by an increase in weeds, pests or diseases associated with the new practices - rodents and slugs for Mediterranean, rats and snakes in Brazil for Mucuna as cover crop, sanil in sugar beets, mice in grain crops and progressively greater weed problems in Europe.

Policy Drivers

Constraints	Agroecosystems	Perception
Increased Production Costs	Indo-Gangetic	The need a specialized implement must return to investment.
	European Platform	The potential importance of social costs associated with rural unemployment if conservation agriculture reduces overall labor requirements, or costs associated with environmental pollution if conservation agriculture increases the use of pesticides.

Policy Drivers

Constraints	Agroecosystems	Perception
Non-availability of conservation agriculture implements	European, Mediterranean, Latin American and Asian platform	Suitable implements are not available (?)

The importance of small-scale farmer access to conservation agriculture implements was raised several times, for the most part in the context of southern Brazil, Europe, and South Asia. Animal-traction no-till drills have been developed for small scale farmers in Brazil. In South Asia, the renting in by small farmers of no-till services has become customary. It remains to be seen how the situation in Europe will unfold.

Policy Drivers

Constraints	Agroecosystems	Perception
Lack of subsidies and credit facilities	Latin American	In the agriculture of subsistence without surplus production ome successful examples of programmes oriented to small-scale farmers in Brazil could be a reference for other countries. These programmes included the provision of credit at low interest rates and oriented to farmers groups.
	Mediterranean	The interest of the EU are very variable and don't respond to long-term requirements for CA systems to be developed and adopted. Current policies promoting CA should change towards natural resources - soil and water- conservation, yield stability, and sustainability of agricultural systems more than to increase the productivity.

Policy Drivers

Constraints	Agroecosystems	Perception
Lack of knowledge	Mediterranean	Lack of information and technical advice about CA technologies taking into consideration site-specific social, economic and environmental aspects, on the time needed to reach a complete adaptation or stabilization of the CA based cropping system and on crop rotations performance.
	Subtropical region of Bolivia	Rural extension is very weak, technicians are not convinced by the benefits of CA, technical messages for farmers are not clear, there is, also, a lack of scientific information mainly for small-scale farmers and where local languages predominates among farmers and the high unliterary also hinders the farmers' access to external information.

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Policy Drivers

Constraints	Agroecosystems	Perception
Lack of knowledge	Brazil and Argentina	Although improvement is always possible, it appears that, information on CA is widely available.
	Indo-Gangetic Plains	Information on wheat no-till is circulating swiftly, but information on other conservation agriculture practices has not yet been widely distributed.
The Problem of " Mind Set"	Brazil and Argentina	Although improvement is always possible, it appears that, information on CA is widely available.