To feed a growing world population, we have no option but to intensify crop production. But farmers face unprecedented constraints. In order to grow, agriculture must learn to save.

Farming systems that save and grow

Crop production intensification will be built on farming systems that offer a range of productivity, socio-economic and environmental benefits to producers and to society at large.

Farming systems for sustainable crop production intensification will be built on the three core technical principles:

- *simultaneous achievement* of increased agricultural productivity and enhancement of natural capital and ecosystem services;
- *higher rates of efficiency in the use of key inputs,* including water, nutrients, pesticides, energy, land and labour;
- *use of managed and natural biodiversity* to build system resilience to abiotic, biotic and economic stresses.

Those principles will be implemented using seven recommended management practices:

- minimum soil disturbance;
- permanent organic soil cover;
- pecies diversification;
- use of high-yielding adapted varieties from good seed;
- integrated pest management;
- plant nutrition based on healthy soils;
- and efficient water management.

alfalfa

Integrated crop-livestock production

Integrated crop-livestock production systems are practised by most smallholders in developing countries. Pastureland has important ecological functions: it contains a high percentage of perennial grasses, which sequester and safely store large amounts of carbon in the soil at rates far exceeding those of annual crops. That capacity can be further enhanced with appropriate management – for example, by replacing exported nutrients, maintaining diversity in plant species, and allowing for sufficient recovery periods between use of land for grazing or cutting.

In conventional farming systems, there is a clear distinction between arable crops and pastureland. With SCPI, this distinction no longer exists, since annual crops may be rotated with pasture without the destructive intervention of soil tillage. This "pasture cropping" is an exciting development in a number of countries. In Australia, pasture cropping involves direct-drilling winter crops, such as oats, into predominantly summer-growing pastures of mainly native species. Benefits suggested by field experiments include reduced risk of waterlogging, nitrate leaching and soil erosion.

Practical innovations have harnessed synergies between crop, livestock and agroforestry production to enhance economic and ecological sustainability while providing a flow of valued ecosystem services. Through increased biological diversity, efficient nutrient recycling, improved soil health and forest conservation, these systems increase environmental resilience, and contribute to climate change adaptation and mitigation.

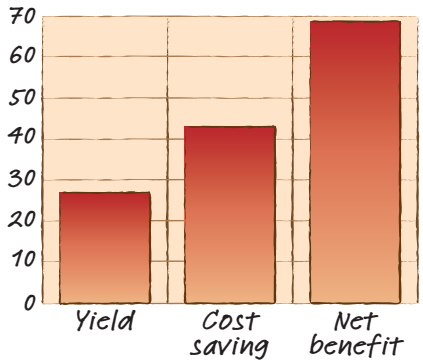
Sustainable rice-wheat production

Sustainable productivity in rice-wheat farming systems was pioneered on the Indo-Gangetic Plain of Bangladesh, India, Nepal and Pakistan by the Rice-Wheat Consortium, an initiative of the CGIAR and national agriculture research centres. It was launched in the 1990s in response to evidence of a plateau in crop productivity, loss of soil organic matter and receding groundwater tables.

wheat

The system involves the planting of wheat after rice using a tractor-drawn seed drill, which seeds directly into unploughed fields with a single pass. As this specialized agricultural machinery was originally not available in South Asia, the key to diffusion of the technology was creating a local manufacturing capacity to supply affordable zero tillage drills. An IFPRI study found that zero tillage wheat provides immediate, identifiable and demonstrable economic benefits. It permits earlier planting, helps control weeds and has significant resource conservation benefits,

Financial advantage of zero tillage over conventional tillage in Haryana, India (US$/ha)

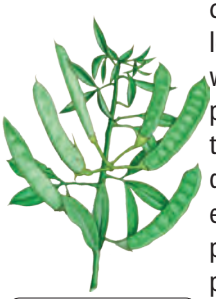


including reduced use of diesel fuel and irrigation water. Cost savings are estimated at US$52 per hectare, primarily owing to a drastic reduction in tractor time and fuel for land preparation and wheat establishment. By recent estimates, around 620 000 farmers on 1.8 million ha of the Indo-Gangetic Plain have adopted the system, with average income gains of US$180 to US$340 per household.

Replicating the approach elsewhere will require on-farm adaptive and participatory research and development, links between farmers and technology suppliers and, above all, interventions that are financially attractive.

Agroforestry

Agroforestry systems, involving the cultivation of woody perennials and annual crops, are increasingly practised on degraded land, usually with perennial legumes. Conservation agriculture works well with agroforestry and several tree crop systems, and farmers in both developing and developed regions practise it in some form. These systems could be further enhanced by improved crop associations, including legumes, and integration with livestock. Alley cropping is one innovation in this area that offers productivity, economic and environmental benefits to producers. Another example is the use of varying densities of "fertilizer trees" that enhance biological nitrogen fixation, conserve moisture and increase production of biomass for use as surface residues.



tagasaste

maize

Higher yields without agrochemicals

In manual smallholder systems, herbicides can be replaced by integrated weed management. For example, since conservation agriculture was introduced in 2005 in Karatu district, the United Republic of Tanzania, farmers have stopped ploughing and hoeing and are growing mixed crops of direct-seeded maize, hyacinth bean and pigeon pea. This system produces good surface mulch, so that weed management can be done by hand without need for herbicides. In some years, fields are rotated into wheat. The overall results have been positive, with average per hectare maize yields increasing from 1 tonne to 6 tonnes. This dramatic yield increase was achieved without agrochemicals and using livestock manure as a soil amendment and fertilizer.

Ripper-furrower system in Namibia

Farmers in the north of Namibia are using conservation agriculture practices to grow drought tolerant crops, including millet, sorghum and maize. The system uses a tractor-drawn ripper-furrower to rip the hard pan to a depth of 60 cm and form furrows for in-field rainfall harvesting. The harvested water is concentrated in the root zone of crops, which are planted in the rip lines together with a mixture of fertilizer and manure. Tractors are used in the first year to establish the system. From the second year, farmers plant crops directly into the rip lines using an animal-drawn direct seeder.

Crop residues are consumed mainly by livestock, but the increased biomass produced by the system also provides some residues for soil cover. Farmers are encouraged to practise crop rotation with legumes. Those techniques lengthen the growing season and improve soil structure, fertility and moisture retention. Average maize yields have increased from 300 kg/ha to more than 1.5 tonnes.

Other production systems

Organic farming, when practised in combination with conservation agriculture, can lead to improved soil health and productivity, increased efficiency in the use of organic matter and energy savings. Organic CA farming serves mainly niche markets and is practised in parts of Brazil, Germany and the United States of America, and by some subsistence farmers in Africa. ***Shifting cultivation*** entails the clearing for crop production of forest land that is subsequently abandoned, allowing natural reforestation and the recovery of depleted plant nutrients. Although shifting cultivation is often viewed negatively, it can be adapted to follow SCPI principles. In place of slash-and-burn, shifting cultivators could adopt slash-and-mulch systems, in which diversified cropping (including legumes and perennials) reduces the need for land clearing. Other ecosystem-based approaches, such as the ***System of Rice Intensification***, have also proven, in specific circumstances, to be successful as a basis for sustainable intensification.

Adapted from *Save and grow* (FAO, 2011),
a policymaker's guide to the sustainable intensification
of smallholder crop production
Save and grow can be purchased from:
fao@earthprint.co.uk or through the FAO
online catalogue: www.fao.org/icatalog/inter-e.htm

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