Conservation Agriculture as an Alternative to Slash-and-Burn Systems

Agricultural areas in Central America are predominantly located on hillsides and steep slopes. This type of agricultural landscape necessitates effective and improved soil and crop management practices to maintain crop productivity, reduce land degradation and ensure water availability. Recent extreme weather variability further exposes these rainfed areas to severe water scarcity and drought, hence, a more deliberate and urgent response to management challenges is vital.

In southwest Honduras, Central America, an ancient rural village, Quesungual, was severely denuded and its soil degraded due to the traditional slash-and-burn production system. The Food and Agriculture Organization (FAO), national institutions and local farmers developed the Quesungual Slash-and-mulch Agroforestry System (QSMAS) to improve the livelihoods of the rural poor through increased water resources and food security in sub-humid hillside areas, while maintaining the soil and plant genetic resources for future generations. QSMAS has already been practiced by more than 6,000 resource-poor farmers to produce major staples (mainly maize, bean, and sorghum) in 7,000 hectares of land in southwest Honduras. This improvement led to the restoration of forest cover and the eventual improvement in crop productivity.

The use of QSMAS in Honduras was initiated by FAO, national institutions and local farmers. Building on its initial success, the CGIAR Challenge Program on Water and Food (CPWF) endeavored to scale out this system in other watersheds of Honduras, Nicaragua and Guatemala. An adoption study was then conducted to find out the factors that led to the successful uptake and scaling out of QSMAS and the related challenges and highlights are detailed in this paper.

This positive technology uptake was driven by the substantial contribution of QSMAS to food security, its remarkable resilience to natural extremes of water deficit and water excess, and its suitability to replace the slash-and-burn practice.

About QSMAS

QSMAS is a smallholder production system that combines crop planting with intense pruning of existing trees in secondary forest. This integrated land use management strategy comprises a package of technologies that allow for sustainable management of vegetation, water, soil and nutrients in drought-prone areas of hillsides in the sub-humid tropics. QSMAS is based on principles that contribute to its superior performance in terms of productivity, sustainability and biophysical resilience.

Quesungual is the name of an ancient rural village in southwest Honduras, Central America. The village's name is drawn from three indigenous words that mean soil, vegetation and a convergence of streams.

Approach

Below is a simplified presentation of the steps in establishing a slash-and-mulch agroforestry system.

Steps in establishing a slash-and-mulch agroforestry system

1. Select a well-developed (high amount and diversity of trees and shrubs) naturally regenerated secondary forest.

2. Sow, by broadcast, 'pioneer' crops such as sorghum (*Sorghum vulgare L.*) or common beans (*Phaseolus vulgaris L.*), whose seedlings are capable of emerging through the mulch. Maize (*Zea mays L.*) is not sown as a pioneer crop because too much mulch affects the emergence of seedlings. Moreover, late-season planting (August) does not provide adequate soil moisture for grain filling.

3. After planting, do selective and partial slashing and pruning of dispersed trees and shrubs in fallows. Then, remove firewood and trunks and ensure uniform distribution of the biomass (leaves and fine shoots) which results as mulch.

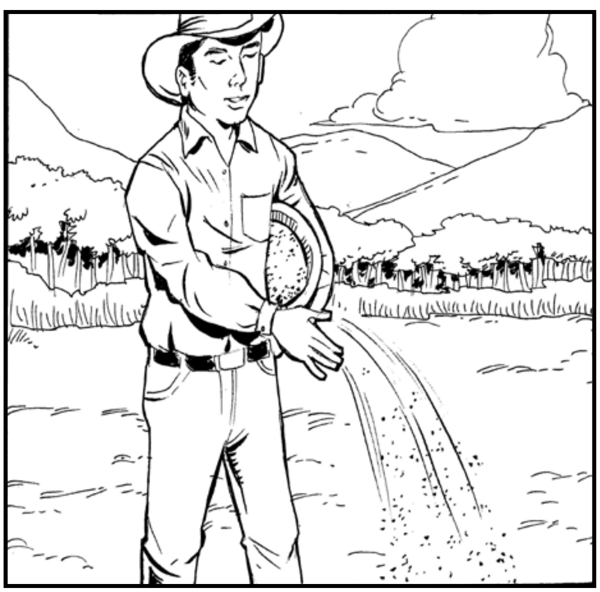
4. The result is a plot with numerous slashed trees, non-slashed high-value multipurpose timber and fruit trees, slashed shrubs (that are used for holding harvested bean plants to avoid infection of bean pods), and a dense layer of mulch.

5. After planting the pioneer crop, continue doing these QSMAS practices: annual production of maize as main crop intercropped with beans or sorghum using zero tillage; continuous slashing and pruning of trees shrubs to eliminate branches (to take out for firewood) and re-growth (to avoid shade for the crops); continuous mulching (from litterfall, slashing of trees and application of crop residues); spot fertilization technologies, and sometimes use of pre-emergence herbicides (Wélchez *et al.* 2006). Carry out these activities for at least 10 to 12 years as this is the system's productive life based on the re-growth potential of trees in the system.

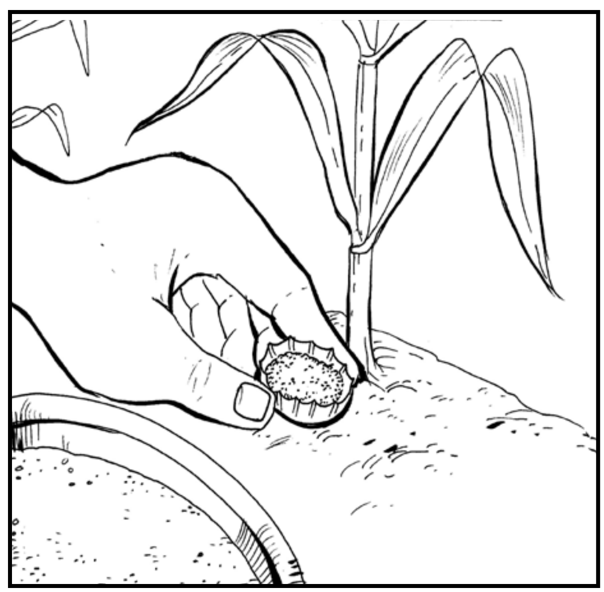
Four key principles of QSMAS

1. **No slash-and-burn:** management (partial, selective and progressive slash-and-prune) of natural vegetation

2. **Permanent soil cover:** continual deposition of biomass from trees, shrubs/weeds and crop residues



3. **Minimal disturbance of soil:** no tillage, direct seeding and reduced soil disturbance during agronomic practices



4. **Efficient use of fertilizer:** appropriate application (timing, type, amount and location) of fertilizer

Benefits of QSMAS

Changes brought about by the implementation of the Quesungual system happened gradually. In the first 3 years, farmers eliminated slash-and-burn, secondary forests and biodiversity started to recover, water became more available and food production became more resilient to extreme weather events. It took up to 7 years for the forests to become fully re-established and for the full benefits to be visible.

The reported benefits of QSMAS validated its viability as an alternative production system in southwest Honduras:

- Food security for over 6,000 small-scale farmers
- Increased productivity and profitability through crop diversification
- High degree of resilience to extreme weather events as a result of buffering provided by the forest environment and protected soil
- Maintenance and recovery of local biodiversity through the natural regeneration of around 60,000 hectares of secondary forest
- Improved environmental quality through the elimination of burning, reduction of cutting of forests and mitigation of land degradation
- Improved availability and quality of water for domestic use
- Increased average value of the maize and bean production from US$ 1,100 per hectare in the slash-and-burn system to over US$ 2,000 per hectare in QSMAS
- Sustainable supply of wood for fuel and construction

Slash-and-mulch agroforestry systems appear to respond best under the following circumstances:

1. **Sub-humid tropical conditions: enough total rainfall for re-growth of trees and/ or regeneration of degraded forest, but also taking into account dry spells so that water conservation in the soil is key to production**
2. **Soils of reasonable fertility: possibility of attaining that with good management of organic matter.**
3. **Sloping but not so steep lands: caution taken to prevent agriculture from destroying their soils.**
4. **Farmer awareness: they know about land degradation, including loss of soil fertility due to erosion and lack of new land for shifting cultivation**

Scaling Out QSMAS

There were observed commonalities in land use practices and degradation in Nicaragua and Honduras. Hence, the CPWF, together with the National Agricultural Research Institute of Nicaragua (INTA), decided to expand and pilot the project to the La Danta watershed in northwestern Nicaragua. The two areas are comparable in the following aspects: similar climate and degraded secondary forest, slash-and-burn is the prevailing production system, deforestation is increasing, crop failure often occurs due to either drought or frequent torrential

The successful adoption of the improved Quesungual system within its area of origin in southern Honduras and its subsequent uptake in several other areas of the country is a compelling story for replacing the slash-and-burn practice. Slash-and-burn is traditionally used by resource-poor, small-scale farmers in the Pan tropical world.

rains and farm families do not have secure food supply and are looking for alternatives.

Arrangements were made for Nicaraguan farmers to visit and have a look at Quesungual plots for replication in their own agricultural fields. After one season, the farmers expanded their experimental farms. Other farmers in the region followed suit as a result of farmer-to-farmer information dissemination.

There were rich exchanges of experiences and lessons learned during field visits and subsequent farmers' trainings on QSMAS, workshops between farmers and researchers, and farmer-to-farmer information dissemination. During the workshop, the farmers revealed that they would willingly abandon slash-and-burn provided there is a good alternative.

The scaling out project in the La Danta watershed yielded encouraging results. About 70 of 120 farm families are now adopting the Quesungual system. About 40 others have abandoned slash-and-burn in favor of conservation methods. Only about 10 still use slash-and-burn.

Key drivers of enhanced QSMAS adoption

1. **Integration of diverse elements without losing focus**. Early on, farmers and institutions realized that, in improving their livelihoods, careful management of land and water is a must. Hence, a focused strategy on managing land and water resources is crucial as they are closely linked to food security, poverty alleviation and land degradation.

2. **Increased production and reduced labor**. With QSMAS, crop yields increased by more than 100%. Increased crop productivity allowed farmers to reduce the area devoted to traditional crops and to grow new crops with market potential. This implies that improved practices associated with QSMAS resulted in enhanced productivity and resource quality and reduced risks. Recent studies conducted by FAO show that producers using QSMAS are also trying new options in their farm areas and exploring new technologies and services. Improvements in soil fertility and water availability allowed for further intensification of the system. Also, QSMAS implied 18% reductions in land preparation and weed control and 27% in other labor requirements (Clercx and Deug 2002).

3. **Integration of local and technical knowledge**. Familiarity of producers with the main components of the system not only enabled the development of QSMAS as an existing indigenous system found in the region; this was also improved by considering local conditions.

4. **Effective participation**. Events and problems in the establishment and management of

the system were dealt with as they occurred within farmers' specific conditions, rather than being anticipated. As a result, the technological focus and general interest of farmers and communities broadened over time to include other issues such as water supply, strengthening of local organizations and health and education. Stakeholder participation in the intervention process is therefore mandatory.

Scaling up of QSMAS was made possible through the effective participation of extension agents and farmer groups as the system built on the capacity of people to use and adapt the system to their own conditions and on the use of participatory validation models. Local development committees and community leaders strongly supported the replication of QSMAS. Students in rural schools were integrated into the whole innovation process by being exposed to different technological alternatives and making them aware of the importance of integrated natural resource management.

The scaling-out process was facilitated through farmer learning tours and exchange visits across farms, communities and municipalities, with learning supplements based on farmers' experiences. Matching technology providers with the farmers' own goals was the guiding principle in the development and adoption of QSMAS. The strategic orientationof the project was complemented with an effective operational framework.

5. **Enhanced competence of farmers and communities**. More than 100 leaders were appointed by their communities to learn the main principles of QSMAS and assist other farmers in the implementation of the system. Over time, farmers' capacity to innovate and solve problems improved. This increased the

A note of caution on QSMAS adaptation and dissemination

Adaptation of QSMAS to other tropical regions may not always result in multiple benefits due to a number of preconditions:

1. **If communities are not convinced on the need to change their traditional production systems to QSMAS it may contribute to its rejection. Stakeholders must know all the key information on the system and commit to support its adaptation.**
2. **QSMAS generates benefits in the short, medium and long terms. If stakeholders expect to obtain full benefits in the short term, efforts to adapt QSMAS may be abandoned. QSMAS strategies for rural improvement must define realistic achievements according to the system's potential and the biophysical and socioeconomic contexts of each target site.**
3. **QSMAS will improve water availability to plants in sub-humid regions with a long (up to six months) dry season and when there is irregularity (dry spells) or insufficiency (shorter rainy season) of rainfall occurs. Significant increases on crop water productivity will not be achieved when water is not limiting production.**
4. **QSMAS management is based on the conversion of naturally regenerated secondary forests into productive plots. Although it is possible to establish the system while the landscape is still in the process of regeneration, the long time frame that is needed to realize benefits may cause the farmers to reject the system.**
5. **QSMAS requires efficient fertilizer applications. Smallholders practicing slash-and-burn agriculture usually do not apply fertilizers. If correction of nutritional limitations in the soil requires significant amounts of fertilizers or amendments, farmers may opt to continue using their traditional practices.**
6. **Farmers managing QSMAS plots require inputs (mainly fertilizers) and possibilities to trade expected surpluses. Lack of any of these will result in failure of the potential agronomic and economic benefits of the system and undoubtedly, to its rejection by farmers.**

spirit of experimentation with soil and water management options and other natural resource management technologies.

6. **Farmers linked to markets**. Market orientation was an important consideration after farmers produced sufficient food for household consumption. The establishment of linkages to outside markets was a key event that accelerated the integration of small farmers to markets and cross-border trade (El Salvador). This opening to new markets has been the key driver for increased crop diversification and the cornerstone for the emergence of a new agribusiness culture among rural communities.

7. **Rural financing**. Communal banks were an important financial mechanism supporting the implementation of QSMAS. Their role was not limited to credit provision. They also acted as an agency for collective action and enforcement of community control. Credit was restricted to farmers who did not burn their land. Membership in communal banks thus developed a new moral order that facilitated the subsequent adjustment of their farming systems and livelihoods.

8. **Supportive policies**. During the implementation of QSMAS, local communities became more aware of the problems associated with burning, deforestation and extensive grazing. As a result, municipal development communities and community-driven associations developed enforcement mechanisms to eliminate burning from agricultural practices. The capacity of local communities and municipalities to protect, regulate and negotiate the use of their land and water resources has been reinforced by the decentralization of power and decision-making promoted by the central government. This produced a positive impact on the scaling up and out of QSMAS.

Lessons learned

- The slash-and-mulch agroforestry system is a resilient and effective practice in tropical areas with a sub-humid climate and where there is good regeneration of secondary forest.

- The slash-and-mulch system is location-specific. Several traditional variants exist in Central America, which are dependent on local vegetation and the way vegetation growth varies on different soils and under different rainfall conditions.

- The spread of the Quesungual system in Honduras and in the pilot area in Nicaragua has shown the important role of research in taking these systems outside their traditional origin.

- The Quesungual system is valuable as a lesson of what can be achieved by conservation agriculture in general.

Conclusion

QSMAS can be a model production system for implementing conservation agriculture to achieve food security and sustainable development in drought-prone hillsides in sub-humid tropics, while providing ecosystem services in the face of land degradation and climate change.

As an adoptable alternative to the traditional slash-and-burn system, QSMAS can improve smallholder livelihoods through eco-efficient use and conservation of natural resources. Participatory validation activities suggest that the conservation agriculture principles embedded in QSMAS can be readily accepted by resource-poor farmers and local authorities in similar agro-ecosystems.

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Bibliography

Castro, A. *et al.* 2009. *Quesungual slash-and-mulch agroforestry system (QSMAS): Improving crop water productivity, food security and resource quality in the subhumid tropics.* CPWF Project Report. Colombo, Sri Lanka: CGIAR Challenge Program on Water and Food.

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Other References

Clerox, L. and M. Deug 2002. *Probreza. Agricultura sostenible y servicios financieros rurales en America Latina: reflexiones sobre un studio de caso en el departamento de Lempira, Honduras.* Centro de studios para el desarrollo rural Universidad Libre de Amsterdam (CDR-ULA), Managua, Nicaragua.

Welchez, L.A., M. Ayarza, E. Amezquita, E. Barrios, M. Rondon, A. Castro, M. Rivera, O. Ferreira, J. Pavon and I. Rao 2006. Quesungual slash-and-mulch agroforestry system (QSMAS). In: *TSBF Institute Annual Report 2006,* 130-133. Cali, Colombia: Centro Internacional de Agricultural Tropical.

Woolley, J 2010. *Legacy of CPWF 1: Quesunual slash-and-mulch agroforestry program*. Unpublished manuscript.