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Cropping System in Relation to Different Crop: A Review

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ABSTRACT

The describing features of any cropping system are the crop rotation and the kind or intensity of tillage. The trend worldwide starting in the late 20th century has been (i) to specialize competitively in the production of two, three, a single or closely related crops such as different market classes of wheat and barley, and (ii) to use direct seeding, also known as no-till, to cut costs and save soil, time, and fuel. The availability of glyphosate- and insect-resistant varieties of soybeans, corn, cotton, and canola has helped greatly to address weed and insect pest pressures favored by direct seeding these crops. However, little has been done through genetics and breeding to address diseases caused by residue- and soil-inhabiting pathogens that remain major obstacles to wider adoption of these potentially more productive and sustainable systems. Instead, the gains have been due largely to innovations in management, including enhancement of root defense by antibiotic-producing rhizosphere-inhabiting bacteria inhibitory to root pathogens. Historically, new varieties have facilitated wider adoption of new management, and changes in management have facilitated wider adoption of new varieties. Although actual yields may be lower in direct-seed compared with conventional cropping systems, largely due to diseases, the yield potential is higher because of more available water and increases in soil organic matter. Attaining the full production potential of these more-sustainable cropping systems must now await the development of varieties adapted to or resistant to the hazards shown to account for the yield depressions associated with direct seeding.

Keywords: *Cropping system, intercropping, soil, environment, crop rotation.*

INTRODUCTION

The concept of an agro ecosystem evolved through extension of the ecosystem paradigm, a central organizing principle in ecology, to agriculture (Lowrance et al., 1984). Historically, the production and sustainability of any given cropping system have been thought to require, as a source, the use of a long (3-years cycle or longer) and assorted crop rotation. For purposes of this work, a cropping system is defined as the integration of management practices and plant genotypes (species and varieties) to produce crops for precise end uses and environmental benefits (Forman, 1995). Management involves creating the growing environment and supply of resources (plant nutrients and water) more favorable for the crop.

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Although the welfares of crop rotation are beyond reproach, to remain viable in today's global commodity markets, farm businesses have to specify in the production of normally two crops (more rarely three), and many specialize in a single crop or in thoroughly related crops, such as different market classes of wheat and barley (Cook, 2006). The productivities gained by focusing, e.g., using the same planter, harvester, and marketing infrastructure for all crops, have progressively outweighed the risks of putting ''all eggs in one basket.'' Moreover, the more uses that are found for commodity crops such as maize and soybeans (e.g., biofuels), with the declining land base existing for agricultural uses, the more intensely these crops will be and can be developed in the same fields as unceasing or near-continuous monocultures. Crop monocultures have been offensive largely for one reason, crop health, and hence yields typically decay, leading to more harmless sites within the field for weeds to embellishment. This practice also requires greater use of pesticides and usually also tillage (soil cultivation) to manage or at least stabilize yields at some economic level. Typical but unproven descriptions for yield decline with crop monoculture have included the following: different crops remove different plant nutrients from the soil until one nutrient becomes limiting, but not if a different (unrelated) crop is then grown in that field; the crop is noxious to itself (allelopathy); as thought after the 19th and early 20th century yield declines of monoculture cotton in the U.S. Southeast, the soil becomes ''worn out'' and ''needs a rest.'' With the exclusion of nitrogen-fixing legumes, any crop sequence where a product is hauled from the field will reduce the soil of its fertility, which must be re-placed as an input. Crop monocultures have been offensive largely for one reason, crop health, and hence yields typically decline, leading to more safe sites within the field for weeds to embellishment (Diter von Wettstein, 2006). This practice also requires greater use of pesticides and usually also tillage (soil cultivation) to accomplish or at least alleviate yields at some economic level. In addition to the economic benefits, leaving all residue of the previous crop on the soil surface protects in contradiction of evaporative loss of water needed to grow the next crop, essentially stops soilloss from wind and water erosion, and results in a buildup (sequestration) of soil carbon as organic matter. Additionally, the stubble with all weeds seeds left on the soil surface provides habitat and food for birds and other wildlife (Erenstein, 2003). Certainly, direct-seed cropping systems can provide the same ecosystem services expected of natural ecosystems, including mitigation of floods and droughts, purification of water and air, recycling of nutrients and protection of biodiversity. North American agriculture has been stirring slowly but steadily in this direction since the Dust Bowl of the1930s. The development of natural ecosystems is precise by a high level of biodiversity, in sharp dissimilarity; intensive agricultural systems involve monocultures associated with high input of chemical fertilizers and pesticides. Intensive agricultural systems have clearly negative impacts on soil and water quality and on biodiversity conservation (Joffre et al., 2004). Alternatively, cropping systems based on carefully designed species mixtures reveal many potential advantages under various conditions, both in temperate and tropical agriculture. This article reviews those potential advantages by addressing the reasons for mixing plant species; the concepts and tools required for understanding and designing cropping systems with mixed species; and the ways of simulating multispecies cropping systems with models. Multispecies systems are diverse and may include annual and perennial crops on a gradient of complexity from 2 to *n* species. A literature survey shows potential advantages such as (1) higher overall productivity, (2) better control of pests and diseases, (3) enhanced ecological services and (4) greater economic profitability. Agronomic and ecological conceptual frameworks are examined for a clearer understanding of cropping systems, including the concepts of competition and facilitation, above- and belowground interactions and the types of biological interactions between species that enable better pest management in the system. After a review of existing models, future directions in modelling plant mixtures are proposed. We conclude on the need to enhance agricultural research on these multispecies systems, combining both agronomic and ecological concepts and tools.

Cropping System

The term cropping system refers to the crops and crop sequences and the management techniques used on a particular field over a period of years. This term is not a new one, but it has been used more often in recent years in discussions about sustainability of our agricultural production systems (Gliessman, 2007). Several other terms have also been used during these discussions:

Allelopathy is the release of a chemical substance by one plant species that inhibits the growth of another species. It has been proven or is suspected to cause yield reductions when one crop follows another of the same family—for example, when corn follows wheat. Technically, damage to a crop from following itself (such as corn following corn) is referred to as auto toxicity. In many cases the actual cause of such yield reduction is not well understood, but it is generally thought that the breakdown of crop residue can release chemicals that inhibit the growth of the next crop. So keeping old-crop residue away from new-crop roots and seedlings should help to minimize such damage.

Double-cropping (also known as sequential cropping) is the practice of planting a second crop immediately following the harvest of a first crop, thus harvesting two crops from the same field in one year. This is a case of multiple cropping, which requires a season long enough and crops that mature quickly enough to allow two harvests in one year.

Intercropping is the presence of two or more crops in the same field at the same time, planted in an arrangement that results in the crops competing with one another.

Monocropping, or monoculture, refers to the presence of a single crop in a field. This term is often used to refer to growing the same crop year after year in the same field; this practice is better described as continuous cropping, or continuous mono cropping.

Relay intercropping is a technique in which different crops are planted at different times in the same field, and both (or all) crops spend at least part of their season growing together in the field. An example would be dropping cover-crop seed into a soybean crop before it is mature.

Strip cropping is the presence of two or more crops in the same field, planted in strips such that most plant competition is within each crop rather than between crops. This practice has elements of both intercropping and monocropping, with the width of the strips determining the degree of each.

Crop rotations, as a primary aspect of cropping systems, have received considerable attention in recent years, with many people contending that most current rotations are unstable and (at least indirectly) harmful to the environment and therefore not sustainable (Ewel, 1999). Many proponents of "sustainable" agriculture point to the stability that accompanied the mixed farming practices of the past, in which livestock played a key role in utilizing crops produced and in returning manure to the fields. Such systems can still work well, but reduced livestock numbers, fewer producers, and increased crop productivity have meant that such systems are likely to work well for a relatively small segment of agriculture.

Corn–Soybean–Wheat Cropping Systems

Though corn and soybean stay the primary crops of choice for most producers, there is still great attention in finding other arrangements of crops that can provide similar or greater profits, more stability of yield and income, and some lessening in risks that corn and soybean crops share (Wibawa et al., 2003). One such system is a 3-year rotation that comprises wheat along with corn and soybeans. While the double-cropping system often includes these three crops, questions remain unanswered about the extent to which the wheat–soybean double-crop represents one or two crops, from a standpoint of effects on the next season's crop. The sequence of corn, soybean, and wheat has little effect on corn yield, though corn following soybean yielded slightly more than corn following wheat (Nafziger, 2006). Economic returns for these systems depend, of course, on crop prices and input costs. But results of this research indicate that three-crop rotations including wheat can be economically competitive at current crop price ratios. Drawbacks to the inclusion of winter wheat in northern include the occasional effort in getting the wheat crop planted on time following harvest of corn or soybean. The sequence in which the crops are grown does not affect yields much in most years, but it can be easier to plant wheat following soybean, both because of earlier harvest and because of less crop residue.

Cropping systems will need to change

Some who look at cropping systems in terms of ecological principles oppose that current cropping patterns are so unstable that changes must be made soon to prevent disaster (Gliessman, 2007). There is historical evidence that some cultures have been demolished as a consequence of depending too much on a single crop or a few crops, though it is not clear that the methods of production were the problematic as much as lack of means to adequately manage insects and diseases. Yields of some major crops in major growing areas of the world have stagnated in recent years, in some cases without a clear cause, even as genetic potential of these crops continues to increase (Smith et al., 2002). Thus the answer to the question of whether cropping systems will need to change is "probably," though there is very little evidence pointing to specific changes that will have to be made. As long as crops are produced using sound agronomic principles, with a minimum of pesticides, and with awareness of the need to preserve the soil and minimize effects on the environment, we will stay flexible enough to meet challenges to current crops as they come.

CONCLUSION

Crop monocultures have been offensive largely for one reason, crop health, and hence yields typically decay, leading to more harmless sites within the field for weeds to embellishment. This practice also requires greater use of pesticides and usually also tillage (soil cultivation) to manage or at least stabilize yields at some economic level. Typical but unproven descriptions for yield decline with crop monoculture have included the following: different crops remove different plant nutrients from the soil until one nutrient becomes limiting, but not if a different (unrelated) crop is then grown in that field. Crop rotations, as a primary aspect of cropping systems, have received considerable attention in recent years, with many people contending that most current rotations are unstable and (at least indirectly) harmful to the environment and therefore not sustainable. Economic returns for these systems depend, of course, on crop prices and input costs.

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Author Contribution

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REFERENCES

Altieri, M. A. (1999). The ecological role of biodiversity in agroecosystems. *Agric Ecosyst Environ 74*, 19–31.

Altieri, M. A. (2002). Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agric Ecosyst Environ 93*, 1–24.

Bergen, S. D., Bolton, S. M., & Fridley, J. L. (2001). Design principles for ecological engineering. *Ecol Eng 18*(2), 201–210.

Blandin, P. (2009). De la protection de la nature au pilotage de la biodiversité. Sciences en questions, Ed. Quae., France.

Brown, L., Flavin, C., & Fench, H. (2000). State of the world 2000. W.W. Norton and Cie, London, ISBN 0-393-04848-9

Clergue, B., Amiaud, B., Pervanchon, F., Lassere-Joulin, F., & Plantureux, S. (2005). Biodiversity: function and assesment in agricultural areas. *Agron Sust Dev 25*, 1–15.

Connor, D. J. (2001). Optimizing Crop Diversification. In: Nosberger, J., Geiger, H. H., & Struik, P. C. (Eds) Crop Science: progress and prospects. *CAB International*, pp 191–211.

Conway, G. (1998). The doubly green revolution: food for all in the twenty-first century. *Cornell University Press*, Ithaca.

Dalgaard, T., Hutchings, N. J., & Porter, J. P. (2003). Agroecology, scaling and interdisciplinarity. *Agric Ecosyst Environ 100*, 39–51.

Dawson, T., & Fry, R. (1998). Agriculture in nature's image. *TREE 13*, 50–51.

Deguine, J. P., (ed.) Ferron, P., & (ed.), Russell, D. (2008). Protection des cultures: de l'agrochimie à l'agroécologie. Versailles, Ed. Quae.

Delalibera, I., Jr, & Hajek, A. E. (2004). *Neozygites tanajoae* sp. nov., a pathogen of the cassava green mite. *Mycologia 96*(5), 1002–1009.

Denison, F., Kiers, T., & West, A. (2003). Darwinian agriculture: when can humans find solutions beyond the reach of natural selection? *Q Rev Biol 78*(2), 145–168.

Doré, T., Makowski, D., Malézieux, E., Munier-Jolain, N., Tchamitchian, M., & Tittonell, P. (2011). Facing up to the paradigm of ecological intensification in agronomy: revisiting methods, concepts and knowledge. *Eur J Agron*. doi:10.1016/j.eja.2011.02.006

Dupraz, C., & Capillon, A. (2005). L'agroforesterie: unevoiede diversification écologique de l'agriculture européenne? Cahier d'études DEMETER. Economie et Stratégie agricole, Paris, pp 101–113.

Eichhorn, M. P., Paris, P., Herzog, F., Incoll, L. D., Liagre, F., & Mantzanas, K. (2006). Silvoarable systems in Europe—past, present and future prospects. *Agroforest Syst 67*, 29–50.

Erenstein, O. (2003). Smallholder conservation farming in the tropics: a guide to the development and dissemination of mulching with crop residues and cover crops. *Agric Ecosyst Environ 100*, 17–37.

Ewel, J. J. (1986). Designing agricultural ecosystems for the humid tropics. *Ann Rev Ecol Syst 17*, 245–271.

Ewel, J. J. (1999). Naturel systems as models for the design of sustainable systems of land use. *Agroforest Syst 45*, 1–21.

Forman, R. T. (1995). Land Mosaics: the ecology of landscapes and regions. Cambridge University Press, Cambridge.

Francis, C., Lieblein, G., Gliessman, S., Breland, T. A., Creamer, N., Harwood, S. L., Helenius, J., Rickerl, D., Salvador, R., Wiedenhoeft, M., Simmons, S., Allen, P., Altieri, M., Flora, C., & Poincelot, R. (2003). Agroecology: the ecology of food systems. *J Sustain Agr 22*, 99–118.

Fresco, L. O., & Kroonenberg, S. B. (1992). Time and spatial scales in ecological sustainability. *Land Use Policy 9*(3), 155–168.

Fukai, S. (1993). Intercropping, bases of productivity. *Field Crops Res 34*, 239–467.

Gascon, C., da Fonseca, G. A. B., Sechrest, W., Billmark, K. A., & Sanderson, J. (2004). Bioversity conservation in deforested and fragmented tropical landscapes: an overview. In: Götz, S., da Fonseca, G. A. B., Harvey, C. A., Gascon, C., Vasconcelos, H. L., Izac, A. M. N. (eds) Agroforestry and biodiversity conservation in tropical landscapes. Island Press, Washington, pp 15–32.

Giller, K. E., Witter, E., Corbeels, M., & Tittonella, P. (2009). Conservation agriculture and smallholder farming in Africa: The heretics' view. *Field Crops Res 114*(1), 23–34.

Gliessman, S. R. (2007). Agroecology: the ecology of sustainable food systems, 2nd edn. CRC Press, Boca Raton.

Götz, S., Harvey, C. A., & Vincent, G. (2004). Complex agroforests: their structure, diversity and potential role in landscape conservation. In: Götz, S., da Fonseca, G. A. B., Harvey, C. A., Gascon, C., Vasconcelos, H. L., & Izac, A. M. N. (eds) Agroforestry and biodiversity conservation in tropical landscapes. Island Press, Washington, pp 227–260.

Griffon, M. (2006). Nourrir la planète. Odile Jacob.

Grimm, C. (2001). Economic feasibility of a small-scale production plant for entomopathogenic fungi in Nicaragua. *Crop Prot 20*(7), 623–630.

Gross, K. L., Smith, R. G. (2002). Incorporating ecology into agriculture. *TREE 17*, 490–491.

Gunderson, L. H., & Holling, C. S. (2002). Panarchy. Understanding transformation in human and natural systems. Island Press, Washington

Hatfield, C. B. (1997). Oil back on the global agenda. *Nature 387*, 121.

Hector, A. (1999). Plant diversity and productivity experiments in European grasslands. *Science 286*, 1123–1127.

Hobbs, R. J., & Morton, S. R. (1999). Moving from descriptive to predictive ecology. *Agrof Syst 45*, 43–55.

Holland, J. M. (2004). The environmental consequences of adopting conservation tillage in Europe: reviewing the evidence. *Agric Ecosyst Environ 103*, 1–25.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annu Rev Ecol Syst 4*, 1–23.

Hooper, D. U., Chapin, F. S., Ewel, J. J, Hector, A., Inchausti, P., Lavorel, S., Lawton, J. H., Lodge, D. M., Loreau, M., Naeem, S., Schmid, B., Setala, H., Symstad, A. J., Vandermeer, J. J., & Wardle, D. A. (2005). Effects of biodiversity on ecosystem functioning: a consensus of current knowledge. *Ecol Monogr 75*(1), 3–35.

IITA (2008). Integrated pest management: towards 2015. A business plan. Internal report, IITA. Cotonou, Benin.

Jackson, W. (2002). Natural systems agriculture: a truly radical alternative. *Agric Ecosyst Environ 88*, 111–117.

Jackson, L., Bawa, K., Pascual, U., & Perrings, C. (2005). Agrobiodiversity: a new science Agenda for biodiversity in support of sustainable agroecosystems. *Diversitas Report 4*, 40 pp. Available from: www.diversitas-international.org/cross_agriculture.html

Joffre, R., Rambal, S., & Ratte, P. (1999). The dehesa system of Southern Spain and Portugal as a natural ecosystem mimic. *Agroforest Syst 45*, 57–79.

Joshi, L., Wibawa, G., Beukema, H., Williams, S., & Van Noordwijk, M. (2003). Technological change and biodiversity in the rubber agroecosystem of Sumatra. In: Vandermeer J (ed) Tropical agroecosystems. CRC Press, Florida, USA, pp 133–157.