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International Journal for Parasitology 29 (1999) 1–5

INTERNATIONAL Journal for PARASITOLOGY

Sustainable agriculture: how to sustain a production system in a changing environment

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Received 13 April 1998; accepted 17 September 1998

Abstract

During the past 10–15 years, sustainable agriculture has progressed from a focus primarily on a low-input, organic farming approach with a major emphasis on small fruit or vegetable production farms, often described as Low Input Sustainable Agriculture, to the current situation where sustainability is an important part of mainstream animal and plant production units. The US Department of Agriculture programmes cover a broad range of activities, including conserving the natural resource base, enhancing environmental quality, and sustaining productivity of the nation's farms. The use of Geographic Information Systems technology to direct application of fertilisers, pesticides, and herbicides is one example of a rapidly emerging technology that can reduce use of external inputs, protect the agricultural environment, and improve economic returns. This Geographic Information Systems technology also is being used to localise animal pest and disease problems, assist in regulatory or control measures, and identify high risk areas that might need different management systems or should be avoided as sites for animal production. Use of intensive grazing systems also has increased markedly over the past 5–6 years. These systems will allow longer grazing seasons in southern parts of the USA, provide more efficient use of the forages being produced and reduce labour costs in the typical dairy operation. Major animal and plant production agriculture-oriented programmes at the US Department of Agriculture focus on integrated production systems, use of Integrated Pest Management techniques, and development of alternative methods to manage pests and diseases that reduce or avoid the use of drugs and chemicals. The US Department of Agriculture has a programme for sustainable agriculture, the Sustainable Agriculture Research and Education programme, which emphasises alternative approaches for animal and plant production systems. 1998 Australian Society for Parasitology. Published by Elsevier Science Ltd.

Keywords: Sustainable agriculture; Integrated production systems; Grazing systems

1. Introduction

During the past 10–15 years, sustainable agriculture has progressed from a focus primarily on a low-input, organic farming approach with a strong emphasis on small crop/fruit/vegetable farms, often described as Low Input Sustainable Agriculture (LISA), to the present situation where sustainability is a major part of mainstream animal and plant production units. According to the dictionary, "sustainable" can be defined as that which can be kept up or prolonged over a long time period. Production units which are highly sustainable and are protective of the natural resources which serve as their base can be either low input or high input, depending on their structure. For example, in pork

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0020-7519/99/$ - see front matter 1998 Australian Society for Parasitology. Published by Elsevier Science Ltd.
PII: S0020-7519(98)00173-8

production, either an outdoor facility (low input) or a total confinement unit (high input) can be equally protective of the environment and provide similar financial returns, if they are properly managed.

Sustainable agriculture and a concurrent effort, precision agriculture, have both had more involvement by the plant production side of agriculture, but these approaches can be equally valid in meeting challenges or solving problems in the food animal sector as well. In crop production, Global Positioning Systems or Geographic Information Systems (GIS) are increasingly being used to monitor crop yields, target application of fertiliser or pesticides, and assist in comparisons of cultivars within or between crop years. For animal production, GIS technologies may be useful in identifying disease patterns or conducting geospatial epidemiologic assessments.

2. Changes affecting agriculture

Part of having a sustainable agricultural system lies in preparing owners and managers to understand and respond appropriately to the changes that are occurring in agriculture. Rapid changes in technology, markets and marketing strategies, industry structure, increasing environmental concerns, and evolving consumer preferences are major concerns of livestock producers that severely challenge their managerial abilities and threaten their economic and family security. These rapid changes have resulted in a situation which many livestock producers find threatening. Several issues or needs result from these changes which can affect the sustainability of a production unit.

2.1. Increased environmental problems with nutrient/waste management, and air and water quality

Animal production units are increasing in size, community demographics have changed, and the rural-community interface has become closer in proximity. In this setting, environmental issues have become more problematic and are causing increased tensions between farm and non-farm residents, decreasing the ability for both sides to maintain the needed dialogues. The insistence of communities that their environment cannot be invaded by odours, while farmers insist that they must be allowed to continue to operate as they have in the past, requires real effort to find the necessary compromises.

2.2. Decreasing availability of slaughter/processing plants in some regions of the country

As slaughter plants decrease in number and distribution, the remaining plants can be more selective about which animals they will purchase. This has resulted in a bias toward the larger producer who can deliver larger load units with more consistent quality and yield. At the same time there is a potential opportunity for niche market, locally owned, processing outlets, provided that they can manage the problem of meeting large-scale-oriented regulatory issues.

2.3. Financial and market management needs exceed the skill level available on many family farms

The increased level of sophistication of various kinds of grower contracts, the demands of financial institutions for more financial background before making loans, and more diverse ways for marketing of products, has resulted in difficulties for many owners who lack sufficient economic or financial skills.

2.4. Decreasing infrastructure in rural areas to support livestock production for all sizes of enterprise

Due to declining farm and rural populations, much of the infrastructure, such as input suppliers and banks, has disappeared from the local community. However, this situation also can stimulate stronger alliances among producers to gain economies of scale for purchase of inputs and for remaining competitive in the marketing sector.

2.5. Human resource management of the labour force required in livestock production

The size of the work force for an individual farm operation has increased and there is a need for greater uniformity in production principles and

practices which can deliver more uniform products. These changes have resulted in an increased sophistication of labour management and people skills required for a successful operation.

2.6. Demands by the consumer for more and different products

The consumer demands a safe food product which is produced in a humane and environmentally friendly manner. There is a continuing need for Quality Assurance training for producers. As the market becomes more differentiated, product development means focusing on a specific market segment. About 30% of all people buy the least-expensive product, while the remaining 70% can be a target for niche marketing or product differentiation.

2.7. Increasing need for more and better information available to the end user

The producer or other user of the knowledge and educational programmes requires immediate access to information that is accurate and up-to-date. High priority needs include an understanding of the consumer (market)-driven food system, better decision-making and planning skills, better communication skills, understanding of regulatory impacts and the public policy sector. Educational needs also include people skills; how to work with neighbours, manage the labour resources, working with the marketing sector, and entrepreneurial skills.

3. The United States Department of Agriculture programmes

A new educational and research programme, Managing Change in Agriculture [1], is an interdisciplinary programme that is directed toward helping the agricultural community respond appropriately to the many changes which are occurring in modern agriculture. One component of this programme, Integrated Animal Product Systems, recognises the interdependence of all firms in a product system, from providers of animal genetics to sellers of consumer-ready meat, dairy, poultry and aquaculture products. It is intended to help in providing solutions to complex industry-level problems and individual-producer or firm-level problems associated with the many significant changes occurring in these industries. Producers will need to improve genetic-driven product characteristics, sustain animal health and prevent disease, adopt more effective production and processing practices, recycle wastes, develop new products and new markets, respond effectively to threats of sanitary/phyto-sanitary non-tariff trade barriers, and implement new methods of business organisation and economic coordination.

The US Department of Agriculture (USDA), in partnership with the Land Grant University system, fosters close working relationships with clientele and coordination of extension, education and research activities which provide the knowledge and assistance people need to respond to change. There is an increasing need for livestock enterprises to be seen as "neighbour-friendly" and to be integrated into the rural community as an important economic enterprise and not as an environmental problem. Other issues of concern include resource management, long-term sustainability (economic, environmental and natural resources) of production units, and the importance of quality of life for those associated with livestock farming activities.

For the area of livestock production and marketing, there are four specific goals.

1. Facilitate adoption of profitable, integrated production systems by producers. Profitable production of quality food products requires the integration of human, livestock, land and financial resources to meet the changing demands of the market. The programme will include development of comprehensive business plans to provide a profitable business venture and manage risk, alternative organisational structures/alliances for product systems coordination, Hazard Analysis Critical Control Point principles and practices to ensure product safety, and appropriate use of technology to achieve animal production objectives in harmony with environmental and human resource objectives.
2. Increased understanding and response by producers to the changing desires of consumers and

the dynamics of the food system. Programme content will include understanding consumer-driven markets, value-added products, food safety, animal product systems, and the role of independent producers.

3. Producers and others will be helped to understand and respond to changes in information needs within the animal product systems. As producers move from being sellers of livestock and milk which are sold in a commodity market to being part of an Integrated Animal Product System, they will need greater amounts of more detailed information to make knowledgeable decisions and will need to work with other system participants to coordinate their activities. In this programme, producers and other participants in an animal product system will work together to understand the systems functions, information needs, and methods of improving the system.
4. Producers and rural community/urban residents are assisted to discover ways of working together for their mutual benefit. Several environmental and social issues must be resolved in order to have productive agriculture and a supportive community. Programmes will include conflict resolution, public issues education and policy development, nutrient/waste management alternatives, and water and air-quality protection alternatives.

Within the Managing Change in Agriculture programme we have defined the Animal Product System as being market (consumer) driven, resource based, and with a high level of technical sophistication. It is an evolutionary process that continues to move in the direction of greater integration. In order to solve the complex problems which face the livestock industries, many skills and solutions are needed. They extend from those with a major emphasis in the social sciences to the highly technical disciplines such as: human capital; community issues; environmental issues; vision of the industry and entrepreneurial skills; people and managerial skills; products and the consumer; food quality and safety; production technologies; financial management; business operations; integrated production models; and waste management–environment issues.

The programme on Managing Change in Agriculture will be sponsoring regional workshops later this year to consider how such educational programmes can be put in place through the Cooperative Extension Service and other intermediaries as well. At the same time, we are in the process of funding projects which are designed to provide solutions to some of the issues. The Fund for Rural America, a new programme of competitive grants which was initiated in 1997, supports projects across the entire spectrum of agriculture, natural resources and rural development. The programme requires that projects demonstrate a full integration of research, education and extension, so that there is a direct link to the application of new information. Because of the emphasis on applied research and problem solving, several projects which are being supported through this programme are directly focusing on some of these issues which have been identified in the food animal programmes.

Another important programme with Cooperative State Research, Education and Extension Service (CSREES) is the Sustainable Agriculture Research and Education programme, which supports a wide variety of projects across the USA [2]. For fiscal year 1998, the USDA provided a total of US $11.3 M for this programme. Of this amount, $8 M was designated for research projects, with the balance assigned to support of extension programmes. In livestock production, one of the primary efforts relates to the use of forage crops in more innovative ways. There is increasing interest in raising pigs in outdoor facilities that minimise start-up costs, provide a more worker-friendly work environment, and also meet some of the concerns about confinement pig units. While this approach eliminates the need for lagoons or other similar strategies for managing animal waste, it is still necessary to have concern about surface runoff from such facilities that could contaminate ground or surface water supplies.

A major increase in use of managed intensive-grazing systems has occurred in the dairy industry in most regions of the USA. While it may offer the greatest benefits for 12-month grazing in southern parts of the country, there has been very strong interest in northern states such as Minnesota, Wisconsin, New York and Pennsylvania. Use of these

intensively managed grazing systems reduces the need for labour for harvesting and storage of forage crops for later use. During the growing season, the cattle are harvesting the forage themselves rather than having the farmer cut or chop the forage and then bring it to the animals in dry lot settings.

In one project in North Carolina, researchers compared a managed grazing system with a more typical system which relied on row crops for feed, harvested forage and conventional confinement. During the second year, economic returns were similar but it is expected that the grazing systems will be more competitive as the managers become more adept at using this management system. One important note was that veterinary costs were reduced in the grazing system herds. The cows had fewer health problems, especially a lower incidence of mastitis.

Another advantage of the more intensively managed, small paddocks is that the producer can better control the impact of cattle on riparian zones. More frequent movement of cattle with shorter grazing periods in the more sensitive ecological areas was an important feature of this effect.

While intensive grazing systems seem to improve the general health of cattle as cited above, there are other features that need to be examined. Accepted practices for control of internal parasites which have been effective in traditional, large, long-term grazing settings, may need to be examined in this new setting.

As we move toward a greater level of sustainability, the USDA is committed to development of alternative pest-control strategies for crop production. Because of concerns about environmental pollution, we are moving toward more selective use of chemicals or use of chemicals which are more environmentally friendly. One strategy that is being employed is to plant "trap crops" which the insects prefer as a food source. An example of this is the use of black-eyed peas to attract stinkbugs and keep them from damaging the pecan crop. The peas also attract other predator insects that further help to control the undesirable insects.

A new use for the GIS systems is for study of animal and plant diseases. While it can be done rather easily for crops with use of various imaging techniques that recognise changes in plant colour, texture or health, giving the scientist a "picture" of the field with the damaged plants easily identified. slightly different approaches may be helpful in the study of animal and human diseases. One example in parasitology has been the use of GIS mapping to identify areas or locations within a pasture or grazing area that are wet or have other characteristics that indicate they are most likely to give rise to internal parasite infections. By doing such mapping in a comprehensive manner, the manager can then be given guidance about areas which need to be fenced off, or managed in a different manner.

In North Carolina, GIS technology coupled with locator points provided by the Forest Service has been used to identify the location of swine production units and mark those which have pseudorabies. This effort has facilitated the work of animal disease control personnel in focusing their work on key areas where the population of pigs is high and pseudorabies is present. A second use of this information has been to assist pork producers who are considering establishment of new or expanded facilities. By reviewing the data on these maps, they can determine areas with lower pig density and lower incidence of pseudorabies. In this way they are helping to create a more favourable environment for the animals and, hopefully, to reduce disease risks.

As is evident from this brief overview, the USDA–CSREES has a variety of approaches that are directed to the question of sustainability in agriculture, whether it be in plants or animals. We have a strong commitment to this concept and feel that it is a most important issue. Websites for the programmes described are as follows:

1. Managing Change in Agriculture: http://www.reeusda.gov/resd/ag—econ/mchg-01.htm
2. Sustainable Agriculture Research and Education: http://www/ces.ncsu.edu/san/

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[1] Managing change in agriculture. Report of Committee on Integrated Animal Product Systems, Wagner W. Absher C, 1998.

[2] SARE 1997 Project Highlights. USDA–CSREES, SARE Office, USDA, 1400 Independence Avenue, Washington, DC, 20250-2223.