INTEGRATED BIOSYSTEMS

Paul Harris, The University of Adelaide
paul.harris@adelaide.edu.au

Abstract

Integrated biosystems, where the waste from one enterprise is used as a resource in another enterprise, provide a possible solution for waste management, energy supply and employment problems currently facing both industrialised and developing countries. There are a number of successful systems, mainly in tropical regions, but systems are scalable both in size and technological complexity.

Introduction

Among the pressing problems faced by the world, both developed and developing, are the shortage of energy, increased pressure on water supplies and problems of waste disposal. Our western culture of compartmentalising everything and linear pathways involving single use of commodities like water has led to major problems on both the resource and waste sides of our excessive consumption. In recent years many people have looked at these problems and come up with "reduce, recycle, reuse" type projects, which are beginning to have a positive effect, but in Asian countries systems incorporating a more holistic approach and recycling have been followed for many years in small scale agriculture. The term "integrated biosystem" has been introduced to describe the idea of using an inter-related set of enterprises so that the "waste" from one component becomes an input for another part of the system, which reduces costs and improves production and/or income. Some components of such systems have already been adopted, for example treated wastewater has been used for wood lot irrigation, grape marc has been returned to vineyards as organic matter and waste paper has been utilised as broiler litter to name a few, but an integrated system can go further and involves a shift in thinking towards a whole system approach.

Examples

In the traditional Chinese system pig or duck housing was over a pond so animal waste fell into the water, encouraging aquatic growth. Fish that fed on this growth were harvested for food and the pond water, with extra nutrients, used for irrigating crops. Crop residues could be fed back to the livestock so there was an almost closed system.

At the Montfort Boys Town in Fiji the system has been expanded to include mushroom production from spent brewer's grain to break down the ligno-cellulose for utilisation by pigs. The pig waste is anaerobically digested to produce methane for fuel, the algae is harvested for animal food and crops will be grown on rafts in the lake to utilise the high level of nutrients (Ajuyah 1999). Earthworm production and chickens have also been incorporated into this system, which aims for zero emission of wastes to the atmosphere. Other examples can be found at the Tropical Ecological Farm in Vietnam (Rodriguez 1999) and Pozo Verde integrated farm in Columbia (Chara 2000).

Figure 1: Part of the first module set up at Montfort Boys Town Photo by Asifo Ajuyah

Closer to home Berrybank Farm, a family cropping enterprise with a 1000 sow piggery near Ballarat (Victoria), has utilised anaerobic digestion, power generation and worm culture to treat piggery wastes, reducing costs by recycling nutrients and water as well as selling excess power to the grid. This system has been running for over 10 years (Annon. 1998).

On a larger scale, sewage from the Adelaide metropolitan northern area is treated at Bolivar then the "Biosolids" are trucked to approved agricultural sites and water piped to the Virginia horticultural area (United Water 1999). Some of Adelaide's food is produced in these areas, so the cycle is loosely closed.

Figure 2: The Bolivar Waste Water Treatment Plant. Photo United Water

The Roseworthy Project

A group involving the South Australian Research and Development Institute, The University of Adelaide and private enterprise has formed just over 12 months ago to promote the concept of integrated biosystems and establish an integrated biosystem demonstration/research facility, which will be located at Roseworthy Campus. The plan is to use anaerobic digestion and aquaculture to treat agricultural wastes, generating income and facilitating recycling of water and nutrients in the process. Funding has been sought from a range of rural funding bodies, but with little success to date.

Challenges for Integrated Biosystems

As an engineer fairly recently involved in integrated biosystems I see a number of challenges.

The current mindset of separate enterprises and single use needs to change. Of course I am generalising, there are some people who already think of holistic systems and we need to utilise their expertise. People considering an integrated biosystem need to realise that the end result can be achieved bit by bit and that they do not necessarily have to run the whole system themselves.

As an industrialised society we tend to focus on intensive, high technology ways of doing things. I think that at least some components of successful integrated systems will be low or appropriate technology, which will require less management, less maintenance and less capital expense. Nature looks after herself quite well until humans interfere and I think we need to return to more "natural" systems. An example of this is the use of wetlands for water treatment. There should be no "ideal" integrated biosystem, as each application will have different constraints, abilities and interests. What we need to encourage is adaption of example systems to suit individual situations so that each system is a bit different, partly to avoid pushing up input costs by excessive demand and depressing the value of outputs by oversupply.

Selling the social and environmental advantages of this approach by emphasising rural employment generation, income diversification and opportunities for decentralised services

such as electricity production. The current moves to open electricity markets, privatisation and "green energy" all provide opportunities and challenges for the renewable energy industry that integrated biosystems can take advantage of.

Conclusions

Integrated biosystems provide solutions to some of the problems facing society today, in both the developed and emerging nations. The ideas are also very scalable, both in size and technological complexity.

References

Ajyuah, A., http://www.ias.unu.edu/proceedings/icibs/ibs/info/fiji/asifo/montfort-asifo.htm ,1999

Annon., http://www.mov.vic.gov.au/futureharvest/case1.html , http://www.environment.gov.au/epg/environet/eecp/case_studies/berrybank.html , 1998

Chara, J.D., E.D. Pulido & P. Cuellar, "Material flow in Pozo Verde intrgrated farm in CAUCA Valey Province, Columbia", Proceedings of the Internet Conference on Material Flow Analysis of Integrated Bio-Systems, March-October 2000, http://www.ias.unu.edu/proceedings/icibs/icmfa/ chara/paper.htm .

Rodriguez, L. http://www.hcm.fpt.vn/inet/~ecofarm/Default.htm , 1999

United Water http://www.uwi.com.au/general/bolivar_wwtp.html , 1999