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ENVIRONMENTAL SCIENCES

UNIVERSITY OF CANTERBURY AND LINCOLN COLLEGE

NEW ZEALAND

ENERGY IN AGRICULTURE:
A BIBLIOGRAPHY

by

R. G. Pearson

Joint Centre for Environmental Sciences

Occasional Paper No. 3

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THE JOINT CENTRE FOR ENVIRONMENTAL SCIENCES

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INTRODUCTION

This report lists all the references related to energy in agriculture held at Lincoln College by the Joint Centre for Environmental Sciences. The list is complete as of March 1977. It is not the product of an exhaustive search of the literature, but rather a reflection of the major interest of the research programme in progress at the Joint Centre. This programme aims to improve understanding of the use of energy in agriculture in order that the impacts of energy shortages or price rises can be evaluated, and the potential for energy conservation in the sector assessed.

A subsidiary interest is that of the evaluation of the potential for energy farming. The references included on this topic provide only modest coverage of the field. Other workers have assembled material on this subject. For example, DSIR (1976) gives a general bibliography on energy farming, and Shadduck (1975) gives a comprehensive bibliography of close to 400 references on anaerobic digestion of farm wastes. Roller *et al.* (1975) list about 160 references relating to the production of biomass for fuel.

Rathwell and Gales (1976) have produced a compendium of more than 1250 entries on ongoing or recently completed research projects and article abstracts related to fuel requirements and energy conservation in the U.S. agricultural sector. However, most of their bibliography is devoted to references with little direct relevance to energy use. For example, there are only 52 entries related to research on agricultural energy use at the national or state level, whereas there are 153 entries related to the control of insects and fungi.

The scope of the present bibliography is limited to reports related to the supply and use of energy in the agricultural sector, and to the implications of this supply and use on problems, both national or international, of energy and food supply. The agricultural sector is taken as being equivalent to the farm sector, but includes the agricultural supply industries where appropriate, and also extends downstream through processing, distribution and consumption of food in reports that also include the farm sector.

The material in this bibliography was assembled during work on a project entitled "Energy costs of crop production in New Zealand" and financed by the New Zealand Energy Research and Development Committee.

CLASSIFICATION

Each reference is classified into one or more of the following categories, indicated by the letters placed to the left of the first-named author.

A	photosynthetic efficiency
B	energy flow in ecosystems
C	energy use in agriculture at the national level
D	energy use in agriculture at the regional level
E	energy use in agriculture at the local level
F	energy budgets
G	specific inputs
H	energy requirements of agricultural inputs
I	energy conservation
J	alternative supplies of energy
K	energy farming
L	economic evaluations
M	energy modelling
N	carrying capacity
O	overviews
P	bibliographies

The first category, photosynthetic efficiency, is concerned with the efficiency of converting solar energy to stored plant energy via photosynthesis.

Category B deals with the flow of energy in ecosystems, usually involving man. The energy supply in such cases is mostly solar energy, which is then upgraded through the food chain.

Categories C-G cover the use of fossil fuels and electricity in the agricultural sector. This use is examined at the national level for the U.S., the U.K., the Netherlands, Canada, Australia, New Zealand, Israel, Japan and Hong Kong. Some national studies consider only energy use on the farm, whereas others extend from farm to home. Regional studies have been carried out in various states of the U.S., and local studies have been undertaken by way of surveys of small numbers of farms in Australia and India for example. Energy budgets have been carried out, in which the

energy used for the different inputs and stages in the production of crop and animal products is estimated. Such budgets vary with regard to the kind of system, the locality of the system and the period being studied. Such analysis allows comparisons to be made between different production systems, different areas or countries, and different stages of the industrialisation process. Category G covers studies in which attention is devoted primarily to a specific kind of input, such as fertilisers or pesticides.

Most of the studies of energy use are concerned not only with the fuel and power used directly on the farm, but also with the energy used indirectly - to manufacture the fertilisers, fencing wire, etc. These energy quantities are calculated using the technique of energy analysis, a method by which the energy requirements of any good or service can be evaluated. Category H deals with the energy requirements of farming materials, such as fertilisers and tractors, and focusses on the industries upstream of the farm. The calculation of such energy requirements is a feature of almost all the papers in categories C-G.

Energy conservation strategies are discussed in category I, and range over many topics including tillage practices, fertiliser and chemical use, crop and animal production methods, crop drying and transportation.

Category J considers the use of solar energy as a heat source on farms and also other forms of energy not presently part of farming practice.

Energy farming (category K) covers the possibilities that exist for producing energy from farm or forest products by burning biomass directly, or by producing gaseous or liquid fuels from it by anaerobic digestion, pyrolysis, fermentation, distillation and other methods.

Economic evaluations (category L) use data from the energy-use studies mentioned to evaluate the impact of changes of the price of energy on the agricultural sector, in terms of product costs, production changes and consequent changes in food prices.

Energy models (category M) are usually employed in conjunction with economic studies to evaluate price effects and also to measure the impact on the farm sector of changes in energy supply. Many techniques are employed, such as input-output analysis, linear programming, quadratic programming and transportation models.

Carrying-capacity studies (category N) take into account the energy needed for food production when considering the constraints that may exist to human population size nationally or globally.

The overview category covers a wide range of papers in which the major emphasis is on topics such as trends in energy use in agriculture, and the implications of such trends for food producers, and food policy planners. Many of the earlier authors cited noted the increasing dependence of industrialised agriculture on non-renewable fossil fuels. Overview papers often include reviews and critiques of the literature and may include original material. Many of the topics mentioned above are dealt with in overview-type papers.

Category P covers the bibliographies already mentioned in the Introduction.

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