DIRECT ENERGY USE IN THE SASKATCHEWAN AGRICULTURE SECTOR BY FARM TYPE AND END-USE

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Saskatchewan agricultural energy use is analyzed for the year 1980. Statistical data on farm types and sizes are used to create nine representative "farm types" for the Province. Other data sources are consulted for agricultural direct energy use (i.e., fuels, N-fertilizer, electricity and herbicides) and use rates are assigned to each particular energy "end use". Farm and energy data sets are integrated to provide results in the form of (a) total energy use by each farm type, and (b), contribution by each farm type to overall energy use. Further detailed analysis is provided for the dominant farm type. Study concludes with a set of priorities for agricultural energy research and programming.

INTRODUCTION

Rational energy policy-making for agriculture must originate from objective and detailed assessment of current energy use in that sector. Such an assessment allows for effective priorization of energy research and accurate targetting of information, training and financial programs directed at agricultural energy use.

A previous paper (Gayton 1982) examined trends of total direct energy (diesel, gasoline, nitrogen fertilizer) consumption by the agriculture sector as a whole. This paper focusses on direct, variable energy use in a single year (1980) and assigns average energy consumption values to nine different individual farm types and several different on-farm energy end-use components.

METHODOLOGY

All commodities are converted to their energy equivalent (gigajoule) basis, and are set out in Table I. Sources for these data (Natural Gas Producers and Suppliers Association 1979; Wrubleski 1983; Thompson and Gimby 1979; Lockeretz 1980; Leach 1976) varied slightly with one another; in all cases the figures chosen are intermediate values. These values do not include energy expended in fabrication or transport of the commodity. Statistics on farm characteristics were taken from the sources listed in Table II.

The many combinations of farm operations in the Province were reduced to nine modal types, with area and infrastructure characteristics assigned to each based on the data collected (Table III). Barn sizes for AFC-hogs, straight hogs and poultry were taken from Office of Energy Conservation audit data. This sample is small (average 10 barns in each case) and is probably biased toward larger, progressive operations.

TABLE I. ENERGY CONTENT OF FARM ENERGY COMMODITIES

Commodity (unit of measure)	Energy Content (GJ)
Electricity (kWh)	0.0036
Natural gas (m^3)	0.0375
Propane (L)	0.0260
Light fuel oil (diesel) (L)	0.0387
Heavy fuel oil (L)	0.0410
Gasoline (L)	0.0347
Kerosene (L)	0.0387
Wood (kg)	0.0020
Ammonia (anhydrous) (kg)	0.0486
Ammonium nitrate (kg)	0.0561
Ammonium nitrate phosphate (kg)	0.0561
Ammonium phosphate (kg)	0.0561
Urea (kg)	0.0531
Herbicidal sprays (L)	0.1100

TABLE II. SOURCES OF STATISTICAL AND ENERGY DATA

Statistics	Source
Farm size and type	Statistics Canada (1981)
Crop, pasture and hayland area	Sask. Dep. of Agric. (1981)
Grain farm numbers	Canadian Wheat Bd. (1981)
Beef statistics	Beef Stabilization Bd. (1983) (pers. commun.)
Beef statistics	Animal Industry, Sask. Dept. of Agric. (pers. commun.)
Hog statistics	Sask. Hog Marketing Comm. (pers. commun.)
Fuel and fertilizer data	Gayton (1982)
Propane data	Canadian Resourcecon (1980)
Barn size and energy use data	Office of Energy Conservation (1981)
Home heating	Sask. Power Corp. (1980)
Hot water heating	Dumont, R. (1983) (pers. commun.)
Home appliances	Can. Energy Res. Inst. (1982)
Personal transport	Claxton et al. (1981)

TABLE III. MODAL FARM TYPES AND SIZES, SASKATCHEWAN, 1980

	Number	Cultivated (ha)	Hay and Pasture (ha)	Bldg. (m^2)
Annual field crops (AFC)	53 100	281	—	—
AFC –irrigated	1 300	243dryland 60irrig.	—	—
AFC–beef–forage	12 000	150	119	—
AFC–hogs	1 200	160	—	400
AFC–dairy–forage	850	81	180	625
Straight hogs	300	—	—	1640
Straight beef–forage and feedlots–forage	200	—	260	—
Straight poultry	120	—	—	2680
Greenhouses	30	—	—	450
Total farms	69 100			

Farm energy use was rationalized into 11 "end-use" categories and, again working from the statistical base, per-unit usage rates were assigned to each end-use (Table IV). Discussions with farmers led me to conclude that motive fuel use for tillage and other field work would be the largest end-use component in Saskatchewan agriculture, so the rate for this end-use was carefully formulated. In addition to the standard statistical derivation of dividing agricultural fuel use by cultivated land area, tillage fuel use per hectare was taken from several individual farm studies (Thompson and Gimby 1979; Jensen, 1981; Gimby et al. 1982; Russell and Coldwell, 1982). There was a reasonable correspondence between these data and a representative value was chosen.

The maintenance of cultivated hay and pasture ("forage") requires considerably less energy expenditure than the maintenance of Annual Field Crops ("AFC"). Considering low maintenance and harvest energy use, and a 3 to 5-yr renovation schedule, forage energy use was set at one-third the AFC value.

TABLE IV. ENERGY USE RATES, PER UNIT PER YEAR

Field crop operations (tillage, local hauling, N. fert sprays, grain drying)	1.65 GJ/ha
Irrigated field crop operations	5.21 GJ/ha
Forage crop operations	0.55 GJ/ha
Livestock feeding and handling (per farm)	10–40 GJ
Space conditioning	
Dairy barns	0.69 GJ/m²
Straight–hog barns	0.82 GJ/m²
AFC–Hog barns	1.00 GJ/m²
Poultry barns	1.36 GJ/m²
Greenhouse space conditioning	0.66 GJ/m²
Home heating (per house)	252 GJ
Home appliance use (per house)	26 GJ
Home hot water (per house)	22 GJ
Personal transport (per house)	130 GJ

RESULTS AND CONCLUSIONS

Total Saskatchewan use of direct energy inputs is displayed in Fig. 1. Straight grain farm (AFC) energy use predominates, claiming 77% of total use. Figure 2 is a closer look at AFC farm type energy use. The biggest category, tillage and local hauling, reflects the heavy emphasis on field work in current prairie grain farming practice. The second category, home heating, is surprisingly large relative to the production sector. The nitrogen fertilizer figure may be somewhat misleading, since it averages in all farms, and a significant number do not fertilize every year. Other data (Gimby et al. 1982) suggest the fertilizer figure could be up to 50% of total energy consumption on certain farms.

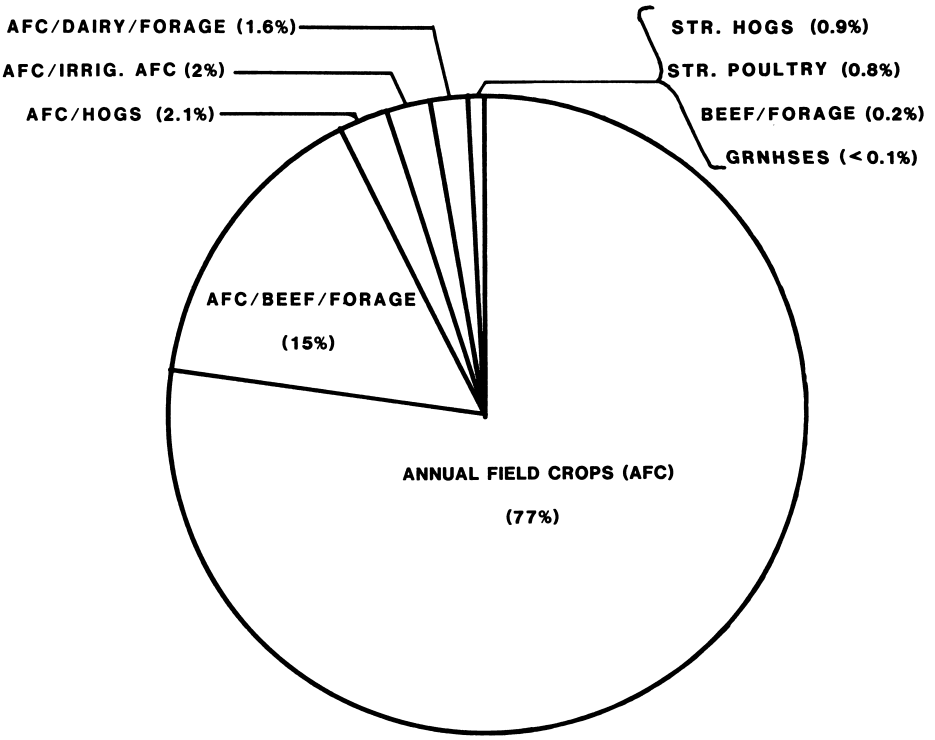

Figure 1. Energy use in nine Saskatchewan farm types.

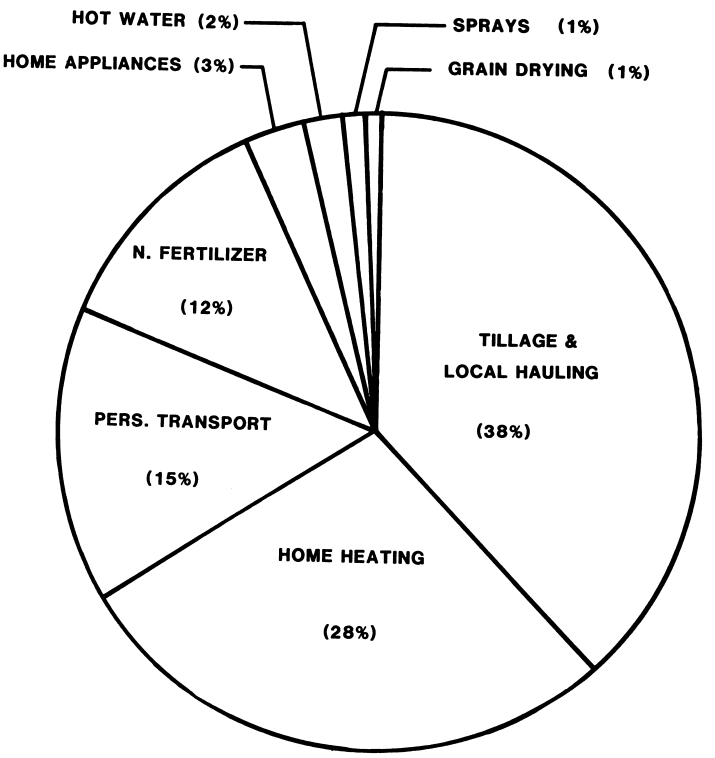

Figure 2. End-use breakdown annual field crops (AFC) farm type.

Researchers in various fields have documented the negative effects of the dominance of the spring-seeded, annual monoculture in Saskatchewan (Rennie et al. 1980; Wilson, 1981; Holm and Henry 1982). From the present data, excessive tillage energy use and minimal nutrient energy cycling also appear to be negative side effects of this cropping system. If the local hauling component (roughly 5% of the AFC individual farm total) is set aside, then we find 33% of AFC energy use (or

25% of total energy use in the entire farm sector) going into motive equipment performing field operations.

Based on this analysis, effective research and programming directed at agricultural energy efficiency in Saskatchewan should be concentrated in the following areas:

(1) A reduction in the frequency of field crop operations in AFC farms and an increase in the fuel efficiency of those operations.

(2) An increase in extension programming (since much of this research is already in place) regarding heating energy efficiency in farm homes.

(3) Increasing nitrogen fertilizer efficiency (placement, timing, rates, legume substitution, etc.) on AFC farms.

(4) The development of individual farm energy use analysis programs that complement existing farm cost analyses.

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