Proceedings of the

Minnesota Turkey Growers Association

Energy Symposium:

Can Litter Management Reduce Energy Requirements?

March 23, 1982

Miscellaneous Publication 15 -- 1982
Agricultural Experiment Station
University of Minnesota

PROLOGUE

The development and organization of this 1982 Energy Symposium resulted from an interest, on the part of a number of Minnesota turkey growers, to utilize their discard turkey litter as a solid biomass fuel to heat their turkey buildings.

The Energy Committee of the Minnesota Turkey Growers Association subsequently held a number of meetings to discuss the litter burning topic toward determining its priority for research funding by M.T.G.A. It was determined that some growers were interested because of a problem with disposal of litter while other growers value their turkey litter as crop fertilizer and were not interested in using it as fuel.

A subcommittee was then appointed to survey the M.T.G.A. membership and determine their interest in attending a seminar on litter burning. The response indicated wide differences in opinion on the value of turkey litter but an overwhelming interest in attending a symposium.

The symposium was developed and sponsored jointly by M.T.G.A., the University of Minnesota Agricultural Engineering Department, and the University of Minnesota Extension Service.

Note: The University of Minnesota Agricultural Experiment Station sponsored the production of this publication. As a miscellaneous publication, it is intended for very limited audiences and distribution is made by the author. Copies of this publication may be purchased from the Department of Agricultural Engineering, 201 Agricultural Engineering, 1390 Eckles Avenue, University of Minnesota, St. Paul, MN 55108 for $4 each, postpaid until the original printing is exhausted. Checks should be made payable to University of Minnesota.

ENERGY SYMPOSIUM PROGRAM

Sponsors: Minnesota Turkey Growers (Energy Committee)
University of Minnesota
Extension Service - University of Minnesota

Chairman: Dr. Peter Poss

9:00 a.m.	COFFEE AND DONUTS
9:30 a.m.	WHY DOES A MINNESOTA TURKEY PRODUCER HAVE TO RAISE WINTER TURKEYS? Jim Richardson, Sales Manager - Jennie-O Foods, Willmar
10:00 a.m.	ARE THERE ADVANTAGES IN YEAR ROUND PRODUCTION OF TURKEYS? Ken Klippen, Assistant Executive Secretary - MTGA
10:30 a.m.	WHAT IS THE AVERAGE COST OF LITTER AND FUEL IN MINNESOTA? Robert W. Berg, Department of Animal Science - University of Minnesota
10:45 a.m.	WHY DO WE NEED TO HEAT A TURKEY BARN? Dr. Ken Jordan, Agricultural Engineering Department - University of Minnesota
11:15 a.m.	MINNESOTA -vs- SOUTHEAST FUEL USE AND COMPARATIVE AND PROJECTED FUEL COSTS. John Hietala, Northern States Power Company
11:45 a.m.	CROP FERTILIZER VALUE OF TURKEY LITTER. Dr. Fred Bensen, Agricultural Economics Department - University of Minnesota
12:15 p.m.	LUNCH
1:15 p.m.	REVIEW OF BIOMASS BURNER TYPES AND A RESEARCH PROPOSAL TO DETERMINE VALUES OF TURKEY LITTER AS FUEL AND TO DEVELOP A TURKEY LITTER BURNER. Dr. Dave Thimson, Agricultural Engineering Department - University of Minnesota
1:45 p.m.	THE COST OF INSTALLING AND OPERATING A BIOMASS BURNER IN A MINNESOTA TURKEY BARN. Terry Gunnell, Swede Stoker - Thunderbay, Ontario, Canada
2:15 p.m.	INCREASING PROFITS THROUGH ENERGY OPPORTUNITIES. Dr. Tom Abeles, I.E. Associates - Minneapolis
2:45 p.m.	PANEL DISCUSSION
3:30 p.m.	ADJOURN

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1982 ENERGY SYMPOSIUM
SUMMARY

M.T.G.A. ENERGY SUBCOMMITTEE CHAIRMAN
DR. P. E. POSS
EARL B. OLSON FARMS, INC.
2500 WILLMAR AVE. S.W.
WILLMAR, MINNESOTA 56201

The events leading up to the development of the symposium were reviewed which involved a number of meetings held by the Minnesota Turkey Growers Association Energy Committee over the past year. The need to address the Minnesota growers energy problem and to fund research to keep the industry competitive with other areas of the United States was pointed out. Over the years, a lot of the resources of M.T.G.A. have gone into research on disease, management, and nutritional work and a priority for research on energy problems needs to be set as a matter of survival. It doesn't help to keep the birds alive and growing well if, in the process, the industry is not cost competitive because of energy costs.

The symposium is a first in Minnesota, addressing engineering needs for the turkey grower, and the program was developed towards providing the grower and the M.T.G.A. Research Committee with current information to be better able to set priorities on energy research needs.

Why Minnesota growers need to produce turkeys in the winter months, as well as during the regular season, was answered very directly by Jim Richardson, Sales Manager with Jennio-O Foods in Willmar, Minnesota, who stated simply that 1.) turkey products must be available for filling and maintaining customer orders year around, 2.) product must come from fresh turkey, and 3.) if the Minnesota turkey grower does not raise the winter turkeys, the processor will be forced to purchase the birds from producers in other states.

The fixed cost advantage of year-round production to the Minnesota grower was very well described by Ken Klippen, Assistant Executive Secretary of the Minnesota Turkey Growers Association. A telephone survey of the industry was conducted to develop a range of variable and fixed costs for each segment of the industry from the breeder men through hatching, feed milling, growing, and processing. By doubling the off season production from the present 20 percent of annual to 40 percent of annual production, a saving or total decrease in costs for all segments was projected to be quite significant at 1.5 to 2.0 cents per pound of turkey.

Dr. Robert Berg, University of Minnesota Extension Poultryman, summarized the questionnaire which had been sent out and which indicated a lot of interest in having the symposium. Additionally, the questionnaire indicated discard litter value ranged from a disposal problem or give-away value to over $20 per ton. Annual costs reported for new litter and fuel were one and two cents per pound of market turkey, respectively, and they were significantly higher for winter off-season production.

The need for heat in a turkey barn was reviewed by Dr. Ken Jordan, Agricultural Engineer at the University of Minnesota. The heat balance of a turkey barn was well described, pointing out that the high fuel use in Minnesota is required primarily to heat the ventilation air to keep the litter dry.

John Hietala, Agricultural Engineer with Northern States Power Company, described the transient current dip in propane gas costs and the astronomically high projected costs for the future. The turkey industry in Minnesota was likened to another energy intensive business like the hot house tomato industry which had to move to warmer climates because they did not address the impending rise in cost of fuel and could not compete.

The value of turkey litter as crop fertilizer was discussed by Dr. Fred Brown, Agricultural Economist at the University of Minnesota. The lack of published information on the quantity and characteristics of Minnesota turkey litter was pointed out indicating a need for research work in this area.

The afternoon program involved three presentations which were aimed at providing three possible directions the Minnesota Turkey Growers Association could go in researching answers to the litter/energy problem.

1. Dave Thimson in Agricultural Engineering at the University of Minnesota described a research proposal to characterize discard turkey litter as a biomass fuel and to develop a prototype burner which the industry could manufacture.

2. Wells Oswalt, representative for Anga Varme, Ltd. in Thunderbay, Ontario, filled in for their company engineer, Terry Gunnell, who was not able to attend. The Swede Stoker biomass burner was described, as well as their guarantee to burn 50 percent turkey manure with wood or bark chips in a large furnace installation. Proposals were made this past year to two Minnesota turkey growers for multiple building farms using hot water boilers; however, the systems, costing in the area of $200,000 for four turkey buildings, were not purchased.

3. Dr. Tom Abeles, with I.E. Associates, described a consultant's approach to the litter/fuel problem with a number of solutions that should be researched and looked at including the use of discard turkey litter as a feed ingredient for cattle.

Following the formal presentations, a panel discussion was held with all the speakers participating as panel members. A number of points made by the speakers were clarified.

Frank Gessel, Swanville, Minnesota, took the podium and addressed the need for developing a system to utilize turkey litter as fuel and proposed contributions be made by individual growers and interested organizations to purchase a burner for an existing turkey building and get a project started immediately.

The chairman reminded the audience of the original intent of the symposium, which is to provide the M.T.G.A. Research Committee with more information so that an intelligent decision can be made concerning the priorities for, and the use of, M.T.G.A. resources for research in 1982-83. Those decisions will be made in the next two months and funding is scheduled for July first.

Finally, the audience was questioned concerning their interest in another symposium next year, and their response was very favorable.

WHY DOES A MINNESOTA TURKEY PRODUCER HAVE TO RAISE WINTER TURKEY?

JAMES RICHARDSON
VICE PRESIDENT/SALES & MARKETING
JENNIE-O FOODS, INC.
2505 WILLMAR AVENUE, SW
WILLMAR, MN 56201

I truly appreciate this opportunity to speak to you briefly on "Why does a Minnesota turkey producer have to raise winter turkey." On this subject, I shall only deal with the need for growing winter turkeys as it relates to sales and marketing.

The future of our industry is completely dependent on turkey availability twelve months of the year, particularly during the winter months.

Many changes have taken place in the marketing of turkey in the past 20 years. Gone are the days when processors can utilize canner turkeys over the winter for boning.

The turkey industry has become a 52-week-a-year business. In the year 1980, this became apparent when the per capita consumption of turkeys was approximately 71% in those products that require yearly production:

24.3% cut up
35.3% further processed
10.9% fresh

The remaining 29% was sold in the frozen whole form.

These figures may surprise you since most people still consider turkey a Thanksgiving and Christmas bird. Turkey is now a "bird for all seasons"; and without winter production, the Minnesota turkey industry could be adversely affected. Our future could be in the hands of Eastern and Western growers and processors.

If we cannot fill live production requirements, then midwestern processors must turn to producers in areas where winter product is available. This does, however, leave the processor in a precarious position to fill his total needs if sufficient live product is not available.

I remember back in the early 1950's when meetings were held by the growers and processors on how our industry could eliminate the problems that were plaguing us. The problem then being how to overcome the lack of movement of the undergrades. A solution had to be found. This was the beginning of further processing.

What was started then, I believe, has made our industry stronger. During the past 20 to 25 years, the turkey industry has changed in five basic phases. Each phase created a greater need for year-round production and established turkey as a daily consumption item in the minds of the consumer - a vital part in growth of our industry.

Phase I

This was the development of low cost further processed product as a means of utilizing the undergrade turkeys. These products were low in quality from the standpoint of sliceability and were used primarily for industrial feeding. Research and development personnel learned greatly from customer reaction and suggestion.

We experienced many problems which had to be overcome if further processing and cut up were to survive, such as what to do with the drumsticks, thighs, etc. Supermarkets in the United States were slow to accept these turkey products. If it were not for Germany and Hong Kong taking on large amounts of these items, this new merchandising program may not have succeeded. At this point, sales had followed the Thanksgiving and Christmas sales demands.

Phase II

This was the development of more refined further processed products such as oven-roasted turkey breast and consumer turkey roast. Phase II was to change the course of our industry. No longer was further processing produced totally from undergrade turkey, but rather a means of utilizing grade "A" turkeys in a form other than whole turkeys for the supermarkets as well. As this type of sales increased, so did the sales of drumsticks, thighs, etc., in the domestic market. The export market, further processed, and cut up had a future.

At this time, speciality product sales were difficult to come by. A few pioneering companies went to a great deal of time and expense to sell the new further processing concept. Speciality salesmen were hired to travel the United States to preach the word: Further processed turkey was of value.

It was not easy. The biggest hurdle these sales people had was "We only serve turkey at Thanksgiving and Christmas." Time has proven that the early pioneer, in producing and merchandising of turkey and speciality products, built a solid base for everyone to benefit from.

Phase III

With the development of oven-roasted breast for the Food Service trade, it was found that we had developed a high quality turkey product that could be used in the delicatessen throughout the country, on the East Coast in particular. Today, this product is one of the largest movement items in the delicatessen. The per pound consumption of turkey would profit because of the ability of the consumer being able to purchase high quality turkey in any quantity desired.

Phase IV

This was the development of sales for fresh turkey and turkey parts. Most major supermarkets started displaying fresh turkey on a daily basis. The need for daily production, especially during the first four months of the year, became a necessity. Turkey was now an everyday item in the supermarkets. This phase would have been a failure if turkey was only available July through December. Frozen turkeys could not be used because of the poor shelf life that would be obtained. Turkey was fast becoming a staple item in menu planning of Mrs. Housewife.

Phase V

The fifth phase was probably the most dramatic in that it created a new outlet for turkey throughout the United States, not only in sales, but in the minds of the consumer. This was the development of the cured turkey products, such as turkey wieners, bologna, salami, ham, pastrami, as well as roasted and smoked turkey breast in smaller consumer sizes. These turkey items have made such an impact on the consumer that major meat companies such as Oscar Meyer and Armour are now producing like items. The entrance of the red meat industry into the production of speciality turkey products cannot but help increase the demand for our turkeys. Our industry is no longer a stepchild.

Each phase has contributed to the overall growth and improvements of the turkey industry.

In 1971, the New York hen market was four to five cents per pound higher than the tom market. In 1981, just ten years later, toms were the same or exceeded hen prices most of the year. So you can see speciality turkey products have enhanced the market value on toms to the point where they equal the value of hens . . . a long way from our experience of 1971. In the long run, higher tom turkey value shall increase the value of hens.

A question you might be asking yourself is "Why don't the further processors produce their winter requirements from frozen canner turkeys?"

The problem that develops from this theory is that turkeys that are in storage at the end of the year are turkeys that were packed for supermarket sales and contain some form of basting solution, such as butter, broth, or oil, therefore, becoming difficult to use in further processing. In cooked products, various ingredients are used to enhance flavor, sliceability, etc. The task of purchasing the turkey for exact ingredient specifications to accomodate each company's formula becomes a near impossibility. The U. S. Government will not permit any ingredient in a product that is not listed in the approved ingredients formula.

Canners are not a viable solution for winter month production.

Contracting to obtain canners from other processors is difficult as these packers are producing for their own needs. Thus, one cannot plan its sales and marketing on an uncertain availability. Jennie-O, for one, is not in a position to pack canners because all turkeys grown and scheduled for production in October and November are utilized during this time period.

The cost of storage, interest cost, cost of handling, shrinkage in defrosting, and more important, the loss of quality and shelf life eliminates our ability to utilize these turkeys in our speciality products on a regular basis.

In my personal opinion, turkeys grown and processed in the winter months do not contribute to the depressed turkey market. Depressed market conditions are caused by the overproduction in September, October, and November. Turkeys must be produced for consumption. We must NOT grow and produce to fill our plants. Production increases should not be based on a company's desire to increase its volume on existing industry sales. This philosophy means large storage holding.

We must develop increased demand for our products before increasing production. This should be the industry's objectives as we grow. The grocery stimulation program undertaken by the National Turkey Federation in the latter part of 1981 and early 1982 is a perfect example of what our industry can do.

Growing and processing in the normal production period must become orderly, well planned production to sales objectives of every processor in the United States. At Jennie-O, we do everything possible to avoid year end inventories.

Our industry-further processors-consumers need your help. Winter turkeys afford a balanced year-round availability.

Phase VI

Perhaps shall be the further refinement of speciality products. However, objectives shall be on the development of hen turkeys in further processing so the utilization of hens are in products beyond the cut of breast and parts. We are not to far from achieving this goal.

Conclusion

More and more the consumer is demanding higher protein foods. No longer will the average housewife feed her family high fat foods. Because of this attitude, the demand for turkey and turkey products shall increase.

In closing, I would like to emphasize that our industry is totally dependent on the sale of further processed, cut up, and fresh turkey products. The consumer is expecting turkey products in supermarkets and restaurants every week of the year.

We are competing with red meat, and red meat is produced without seasonal variation. Israel, Italy, Switzerland, and Germany have taught us that turkey is a replacement for veal, pork, and beef. Your planning today insures the continued growth of our industry.

Thank you.

ARE THERE ADVANTAGES IN YEAR-AROUND PRODUCTION OF TURKEYS?

Ken Klippen
Assistant Executive Secretary
Minnesota Turkey Growers Association

Are there advantages in year-around production of turkeys? The answer to that question depends on who you ask, because the response is contingent on the perspective of the individual, i.e., whether the individual is involved in growing turkeys, a breeding operation, a hatchery, feed mill, processor, or any combination of integration. In addition, the response from within any one category may offer a disparity of opinions. Whether there are advantages or disadvantages in year-around production depends on the myriad number of variables, each with subvariables that affect that particular operation cost.

The best approach in analyzing year-around production advantages is from the standpoint of fixed costs. Costs that cannot be turned off are fixed costs. Examples of such fixed costs include buildings and equipment, depreciation, labor, general administrative charges, repairs and maintenance, long term debt, etc. When assessed on a per pound of turkey meat basis they may provide the bottom line in determining the advantages in year-around production.

But let's analyze the considerations in year-around production from the perspective of the confines of this energy symposium.

During the decade of the seventies, the production of turkeys in the Midwest accounted for approximately 40 percent of the total U.S. crop. Minnesota alone averaged 15 percent of U.S. total production, and this percentage floated steadily with the increases in total production over the decade. This last year, 1981, North Carolina surpassed Minnesota as the number one turkey producing state. That fact, in itself, is not a problem for most Minnesota turkey producers, especially in light of the terrible market conditions, however the production competitiveness pervades into the marketing channels...markets that are captured and maintained by a specific product. From a consumer's point of view, availability on a uniform basis reinforces repeat usage.

Let's examine the competitiveness by analyzing the costs of producing Minnesota-grown turkeys (Table 1). The single most expensive item in production analysis is feed. With the price of feed presently hovering in the range of \$150 - \$190 per ton, the average price of feed will range between 7½ - 9½ cents a pound. At 8½ cents for an average per pound feed cost, a 19-20 week old tom averaging 25 pounds liveweight with a feed conversion of 3.0 pounds of grain per pound of gain, will price out on a feed per pound of meat basis at 25½ cents. The 16 week old hen at 13.5 pounds with a 2.8 feed conversion will price out for feed at approximately 23½ cents per pound of meat.

Poult costs vary, but picking a range of \$.70 to \$1.15 plus or minus \$.10, or an average cost of \$1.00 yields per pound costs for toms at 4 cents and hens at 7.4 cents. This price would include assessments for sexing, injections and toe clipping.

Fuel costs, as is evident from the energy survey, will fluctuate from ½ cent per pound to over 5 cents per pound and the variables within this cost include the season, the operation type, i.e., semiconfinement or total confinement, and management of heat and ventilation. Some growers managed (the key word in this line) to contain their per pound fuel costs in the neighborhood of 1 cent in light of the coldest Minnesota winter this century. The yearly average will range between 3/4 to 1½ cents a pound.

Litter costs also vary depending on operation types, seasons and management, and will range between 3/4 to 1½ cents a pound.

Medication costs, for coccidiosis, Blackhead, Cholera, Coliforms, and including growth promotants will average 3/4 cent a pound.

Disease is one of those subvariables that can alter a variable and significantly influence the cost per pound estimates by as much as 15 to 20 percent.

The final category is the catchall category and is probably the most difficult to assess on a per pound basis. Segmenting out labor at 2 - 2½ cents a pound, the catchall will cost approximately 5 - 7 cents a pound. This includes water, electricity, buildings and equipment, land, repairs and maintenance, depreciation, insurance, taxes, etc.

Assuming we're in the ballpark for the catchall category costs, the average annual cost of producing turkeys in Minnesota is in the neighborhood of 36 - 46 cents a pound. The average price is obviously hinged on numerous variables and assumes year-around production. Those fixed costs are costs to the grower whether his barns are full or not. Let's examine the fixed costs in other segments of this industry and attempt to apply a cost assessed to in-season production only (Table 2).

Before we do, certain production statistics need to be introduced so you can follow the cost-assessing procedures.

In 1981, the nation's turkey industry produced 164.8 million turkeys. Minnesota, producing at its traditional 15 percent, grew 25.7 million birds. The nation's total tonnage last year was 3.07 billion pounds. Minnesota therefore produced approximatley 470 - 490 million pounds. This figure in extrapolated from the average liveweight at 19.09 pounds times the number of birds produced, or 15 percent of the total tonnage.

With a feed conversion average of 3.0 pounds, Minnesota turkeys consumed 1471.8 million pounds of feed or 735,900 tons.

Producing 740,000 tons of turkey feed for in-season turkey production only would require radical alterations in feed mill labor scheduling. Some feed mills operate on an increased output basis during the in-season, and temper with other feed business such as producing a layer mash. Some feed mills prefer to operate "on an even keel" throughout the year because the management of people is much easier. One operator indicated a ½ to 3/4 cent per pound of turkey savings for labor only through year-around feed mill scheduling.

Most feed mill operators concede that off-season activity is more costly due to repairs and maintenance as well as the increased time for labor and deliveries.

Depreciation and interest on mill buildings and equipment depend on the mortgage relative to tonnage produced and can vary from $1.00 per ton to over $12.00. The long term interest can vary from 6 percent to 16 percent.

To encourage year-around production, some feed mills offer a $2 - $3 incentive to purchase turkey feed in the off-season. This incentive expense can be offset by altering the rations to a winter formula which allows for the turkey's increased demand for energy. This adjustment increases the feed energy and lowers the protein level bearing a cost per ton savings of $2 - $3.

Basically, feed mills operate with a fixed price of $3 - $8 per ton. On a price per pound of feed offered basis with a 3.0 average feed conversion, year-around production yields a $.012 per pound of meat for fixed costs.

At the hatchery the fixed costs on a per poult basis will fluctuate between 8 - 11 cents. This is based on the complement of fixed costs including equipment, depreciation, insurance, general administrative charges, electricity, and repairs and maintenace. Some hatcheries prefer a certain amount of down time in order to clean-up and reduce the incidence of hatchery-borne diseases. Assuming an average of 9 cents per poult with 10 percent mortality (from day one to market) yields an additional 9/10's of a cent per poult. When divided by the average liveweight, the cost of a pound of turkey from the hatchery perspective of fixed costs in ½ of a cent.

From the breeder's perspective, facility costs on a per hen basis approximates $37.50. This is based on 7½ square feet per bird times $5.00 per square foot building costs. 16 percent interest will yield $6 per hen per year, 15 year depreciation will yield 2.50 per hen, and taxes and insurance will add another 90 cents per hen per year. These fixed costs total $9.40. The range will fluctuate from $6.50 to $9.50 based on interest alone. When divided by the average number of eggs produced (90) yields a per egg cost at $.10. With a 70 percent hatchability yielding 63 poults, the per poult fixed cost is $.15. When divided by the average liveweight, the cost from the breeder perspective is 3/4's of one cent.

Those in the know have estimated the cost of buying a new turkey processing complex in the neighborhood of $16 - $20 million. This would depend on many factors including the freezer facilities, number of inspector lines, etc. The fixed costs on a new complex is undoubtedly phenomenial. You would think that every processor would prefer to spread those costs year-around, but that's not the case. One processor operates only 150 days. The line of reasoning is that operating costs rise proportionally with the hours of operation. Concering labor costs...during the down time that labor force draws unemployment.

The range of costs on a per pound basis from the processor's perspective can be as low as 3/4 to 1 cent up to 10 cents. The ballpark figure is 3 - 3½ cents.

Table 3 carries the fixed costs one step further with a scenario that expands off-season production. Assuming that in Minnesota approximately 80 percent of the birds grown are produced in-season allows an estimated 390 million pounds, leaving 20 percent or 100 million pounds off-season. If off-season production was doubled the production scenario shows 590 million pounds produced however the fixed costs are now spread over an extra 100 million pounds. Instead of 4½ cents for fixed costs to the grower on a per pound of turkey basis, his fixed costs are 3½ cents. The feed mill's fixed costs will drop 1/10 of a cent, the hatchery's fixed costs will drop 1/10 of a cent, the breeder's fixed costs will drop 1/10 of a cent, and the processor's fixed costs will be reduced ½ a cent. The net savings by expanding off-season production and spreading fixed costs will approximate 1½ - 2 cents a pound. Assuming North Carolina is on a 60:40 production calendar, this scenario for expanded off-season production would allow Minnesota to compete with North Carolina through increased efficiency of fixed costs.

Off-season production today is no doubt crippling the Minnesota turkey grower. Some growers must produce year-around to face cash flow problems or guarantees of shackle space for his in-season flocks.

Any method of reducing production costs is advantageous to turkey growers in Minnesota. Fuel is one of the major hurdles in producing off-season and off-season will allow the spread of fixed costs. Hence the purpose of this enegy symposium.

There is another crux thatlooms head and shoulders above increasing production efficiencies and that is the market crunches, especially in the first quarter of the calendar year. As one grower put it, "We know how to feed animals better than we know how to feed people." The answer to this crux is this industry's salvation.

ARE THERE ADVANTAGES TO YEAR-AROUND PRODUCTION OF TURKEYS?

Table 1

Cost of Production	Cost Per Pound of Turkey
Feed @ $150 - $190/t 7.5¢ - 9.5¢/lb. 2.8 - 3.0 feed conversion	$.238 - $.255
Poult @ $.70 - $1.15 ± $.10 ($1.00 ave.) 25 lb tom/13.5 lb. hen	.040 - .074
Fuel	.0075 - 5.0
Litter	.0075 - .015
Medication	.0050 - .0075
Disease	*
Labor	.020 - .025
Buildings and Equipment, Repairs and Maintenance, Water, Electricity, Phone, General Administrative Expense, Depreciation, Insurance, Taxes, Interest	.05 - .07
TOTAL COSTS	$.36 - $.46

*Disease may influence category costs

Table 2

Fixed Costs		Cost Per Pound of Turkey
Grower	25.7 million turkeys 470 - 490 million pounds (ave. wt. 19.09)	$.045 - $.05
Feed Mill	735,900 tons of turkey feed $3.00 - $8.00 fixed cost 2000 lbs./t x 3.0 feed conversion	.01 - .012
Hatchery	$.08 - $.11 per poult 19.09 average liveweight	.004 - .006
Breeder	$6.50 - 9.50 per hen 63 poults/19.09	.007 - .008
Processor	$.0075 - $.10	.030 - .035
TOTAL FIXED COSTS		$.101 - $.111

Table 3

A Scenario for Reducing Fixed Costs by Doubling Off-Season Production

	Fixed Costs (cents per pound of turkey)	Doubling Off-Season (cents per pound of turkey)	Net (cents per pound of turkey)
Grower			
25 million turkeys 490 million pound	4.5	3.5	1.0
80:20 production calendar 390 million pounds 100 million pounds			
$22 million fixed costs			
Feed Mill			
740,000 tons	1.0	0.9	0.1
Doubling off-season 880,000 tons needed			
$5.2 million fixed costs			
Hatchery			
$2.5 million fixed costs	0.5	0.4	0.1
Breeder			
$4.7 million fixed costs	0.7	0.6	0.1
Processor			
$14.7 million fixed costs	3.0	2.5	0.5
Ancillary	?	?	?
		Savings	1½ - 2

MINNESOTA TURKEY GROWERS ASSOCIATION

1982 FUEL SURVEY

The rising cost of fuel to heat turkey buildings has put the Minnesota grower and breedermen at a disadvantage. The MTGA Energy Committee is concerned and want to study the use of alternative fuels to help make Minnesota more competitive.

This questionnaire should be completed and returned by February 10, 1982 so that the concern and interest the industry has can be assessed and research priorities can be set.

1. What fuel type(s) are you presently using to brood and finish turkeys?

   Propane_____ Fuel Oil_____ Coal_____ Wood_____

2. What type equipment do you use for your turkey buildings?

   Open Flame Burners_____ Make up air heaters_____

   Air Heat Exchanger_____ Hot Water_____

3. Do you grow winter or off season flocks that are marketed in January through April?_________

   Percent of Annual Production_________

4. Could you estimate your cost per pound of turkey produced the past year?

	Off Season	In Season	Annual
Fuel	________	________	________
Litter	________	________	________

5. Have you considered alternative fuels? _______ Type?_______

6. If satisfactory furnaces were made available to burn turkey manure for fuel, would you be interested in converting? ________

7. Is disposal of manure a problem in your operation? ________

8. How do you dispose of your manure? Give away to neighbors?_______ Use to fertilize your own cropland?_______ Sell to neighbors at $_______/ton.

9. What value do you place on manure as crop fertilizer? $_______ per ton.

10. Would you be interested in attending a half day seminar dealing with the use of turkey litter as a fuel for heating turkey barns?________

P. E. Poss

FUEL COST AS REFLECTED BY THE FUEL SURVEY

Dr. Robert W. Berg
Extension Poultry Specialist
University of Minnesota

The rising cost of fuel has put the Minnesota turkey producer at a distinct disadvantage. A survey was sent out to our Minnesota turkey growers to determine the fuel and litter costs for growing turkeys. Eighty-nine growers returned their questionnaires.

Fuel costs for winter production of turkeys ranged from a high 5.7 cents a pound to a low of 0.74 cents per pound with an average cost of 2.84 cents. The grower with the low cost was not using propane. Fuel costs for in-season production ranged from a high of 4.8 cents to a low 0.28 cents per pound with an average cost of 1.15 cents. This tells us that there is a way to solve the fuel problem. More of the turkey growers must get in the lower range. This means that a lot of growers have changed their brooding system to the heating of a smaller area the first four weeks. The average annual cost was 1.75 cents per pound of turkey sold.

Those of you who filled out the questionnaire are anxious to see the results. Question one and two will not total 100 percent because some of you reported two kinds of fuel used. It seems that the open flame burners and the hot water systems make up the brooding units. Make-up air and heat exchangers are being used primarily in the rearing units.

Question three, the percentage reported is the percent of birds raised during the winter by the ones that reported raising winter turkeys. This percentage should <u>not</u> be interpreted to mean that 26.6 percent of our turkeys are marketed between January 1 and April 30. There is still 28.7 percent of the growers reporting that they do not raise any winter turkeys.

<u>RESULTS OF 1982 FUEL SURVEY</u>

1. What fuel type(s) are you presently using to brood and finish turkeys?

   Propane: <u>96.6%</u> Fuel oil: <u>7.9%</u> Coal: <u>11.2%</u> Wood: <u>2.2%</u> Catalytic: <u>1.1%</u>

2. What type equipment do you use for your turkey buildings?

   Open flame burners: <u>84.3%</u> Make-up air heaters: <u>28.1%</u>

   Air heat exchanger: <u>9.0%</u> Hot water: <u>15.7%</u>

3. Do you grow winter or off season flocks that are marketed in January through April?

   Yes: <u>71.3%</u> No: <u>28.7%</u>

   Percent of annual production: <u>26.5%</u>

4. Could you estimate your cost per pound of turkey produced the past year?

	Off Season	In Season	Annual
Fuel:	2.84 cents	1.15 cents	1.75 cents
Litter:	1.18 cents	0.73 cents	--

5. Have you considered alternative fuels?

   Yes: 57.7% No: 42.3%

6. If satisfactory furnaces were made available to burn turkey manure for fuel, would you be interested in converting?

   Yes: 79.7% No: 20.3%

7. Is disposal of manure a problem in your operation?

   Yes: 17.1% No: 82.9%

8. How do you dispose of your manure?

   Give away to neighbors: 28.0%
   Use to fertilize your own cropland: 54%
   Sell to neighbors at $6.42 per ton (18%)

9. What value do you place on manure as crop fertilizer?

   Per ton: $18.65

10. Would you be interested in attending a half-day seminar dealing with the use of turkey litter as a fuel for heating turkey barns?

   Yes: 88.0% No: 12.0%

There is a great deal of interest in the value of turkey manure for fertilizer. A report put out by the University of Wisconsin gave the following figures for the mineral content of turkey manure. Current values were used to calculate the value.

TURKEY MANURE 25-40% MOISTURE

	Lbs/Ton	Price/Lb.		Value/Ton
N	52	15 cents	=	$ 7.80
P_2O_5	63	23½ cents	=	$14.05
K_2O	42	13 cents	=	$ 5.46
		Subtotal Value		$27.31

	Lbs/Ton	Price/Lb.	Value/Ton
Ca	25	.03 cents	$ .75
Mg	7	.04 cents	$ .28
Mn	0.4	.60 cents	$ .24
Fe	1.32	.22 cents	$ .29
B	0.05	2.50 cents	$ .13
Cu	0.25	2.10 cents	$ .53
Zn	0.24	.68 cents	$ .16
	TOTAL Value of Minerals:		$29.69

Turkey manure also has value for its fiber (humus) and the bacteria that may be present.

WHY DO WE NEED TO HEAT A TURKEY BARN?

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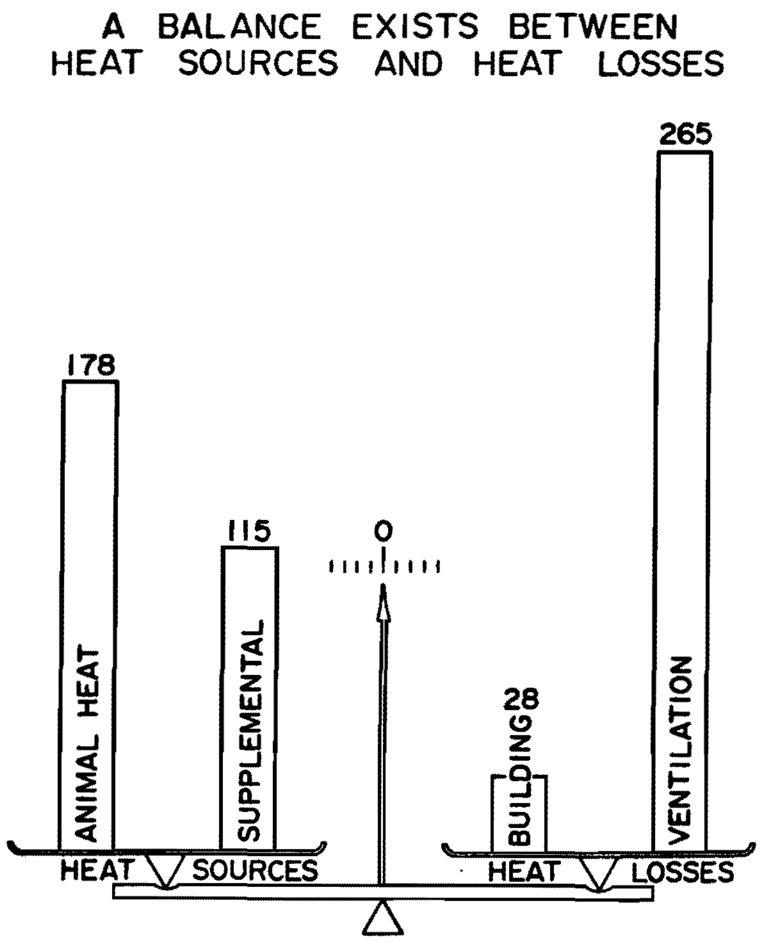
Since the birds produce a considerable quantity of heat, can't we conserve energy and eliminate the need for purchased fuel? The best way to answer this question as well as the question posed in the title is to look at the losses of heat through the walls and in the ventilating air. These must be balanced by the heat produced in the barn by the birds and brooders and any supplemental heat. Figure 1 shows this balance for one set of conditions, but in order for the producer to see what can be accomplished throughout the growth cycle, he would need to calculate a similar set of conditions for his barn over the entire growth cycle. In order to help him with these calculations, a detailed example is appended to this report. In Figure 1 it can be seen that purchased fuel is necessary because the losses are greater than the heat produced by the birds. An analysis of the losses will show where reductions are most appropriately applied.

Losses from the building through the walls, ceiling, and perimeter are the principal envelope losses. The driving force is the difference between air temperatures inside and outside. This temperature difference is multiplied by the area and divided by the thermal resistance. This resistance is often stamped on insulation and includes the combined effect of all building materials and the air film at both the inside and outside surfaces. A well insulated stud wall has a resistance of 13 while the ceiling is often 23 or greater. The normal units from these calculations is British Thermal Units per hour, Btuh. In order to obtain a "feel" of the magnitude of this energy, it is often converted to the daily equivalent of propane in gallons. This is accomplished by multiplying by 24 hours and dividing by the energy in a gallon of propane, 92,000 Btu/gal. The heat losses in a 72' x 186' brooder barn is calculated in Appendix A using an inside temperature of 70°F and an outside temperature of 10°F (which is the average temperature in January in Minnesota). An equivalent loss of propane of 5 gal/day is transferred through the wall. The ceiling with greater area but better insulation resistance has an equivalent loss of 9.1 gal/day of propane.

The losses into the ground are usually thought of as going straight down but the most significant portion (and the only one that we can materially affect) is the perimeter heat loss which occurs to the outside air not the ground temperature. A factor of loss per foot of building perimeter, C, is about 1.8 for uninsulated floors and about 0.9 for insulated perimeters which varies somewhat on the thickness and the placement of the insulation. Even with insulation, more heat is lost through the perimeter than through the walls of the brooder barn. A propane equivalent of 7.3 gal/day is calculated for our example in the appendix. The sum of the heat losses through the building enclosure (5.0 through the walls, 9.1 through the ceiling, and 7.3 through the perimeter) is the equivalent of 21.4 gallons of propane per day.


A BALANCE EXISTS BETWEEN
HEAT SOURCES AND HEAT LOSSES
178
ANIMAL HEAT
115
SUPPLEMENTAL
0
28
BUILDING
265
VENTILATION
HEAT SOURCES
HEAT LOSSES

In sharp contrast is the ventilation heat loss in a brooder barn. This can be calculated in Btuh by multiplying the air temperature difference by the fan capacity. The example worked out in the Appendix for 10,000 toms 8 weeks old shows a propane equivalent of 227 gallons per day. This is more than ten times the heat loss through the building shell!

The fan capacity is established from field observations to maintain litter conditions and bird health. Lower ventilation rates increase the concentration of contaminants, water vapor, pathogens, and noxious gases like ammonia. Dust is usually suppressed because the litter becomes wet and one source of dust is reduced. The effect of ventilation rate on litter condition is dependent on the temperature of the air. Again field observations indicate that temperatures lower than 60°F usually result in wet litter conditions and temperatures above 70°F are usually dusty in upper midwest turkey barns. The exact relationship has not been worked out and further observations are needed. The rates of ventilation in the winter range from 1/4 to 1/3 (CFM per pound of poult) in well managed barns. During extreme winter weather conditions this may be reduced to 1/6 CFM/lb of poult. If this rate is maintained over an extended period the litter usually becomes slick.

The amount of water added to the litter by 10,000 eight week old toms is about 1000 gallons. This must be removed by vaporizing the liquid to water vapor and carrying it out with the ventilation rate. What is the carrying capacity of air? At 100% relative humidity air contains all the water it can carry. The moisture content of air at different conditions is given in Table 2. It is easily seen that air at 50% relative humidity holds only half as much air as 100% but not so obvious is that increasing the temperature by 20°F roughly doubles the water holding capacity.

The amount of water removed from the air can be estimated by multiplying the fan capacity by the change in moisture content increase of the air and also by a constant 4.5. For a barn kept at 80°F and 50% relative humidity (.011 lb water/lb air) taking air from outside at 10°F and 100% relative humidity (.001 moisture content) the water removed in pounds per hour is

$$q \text{ (lb water/hr)} = 4.5 \text{ CFM } (.011 - .001)$$

To remove 1000 gallons of water (8350 lb/day) would require 7732 CFM which is only 1/8 CFM/lb poult. The disparity of this calculation and field observations is probably twofold. First the barn would probably not be kept at 80°F but more significantly the addition of water from leaks or spillage of waters is a common occurrence. Maintaining litter conditions economically using ventilation requires careful maintenance to prevent unncessary water addition to the litter. If ventilation air is required to vaporize and remove water from the litter, additional heat must be purchased.

I have never been in a barn yet that the operator doesn't adjust the ventilation capacity to "improve" the air quality. The ventilation rate in most turkey barns is not known since it is constantly being adjusted by the operator. Most fans are on thermostats and set to barn temperature but these thermostats are usually adjusted up to reduce ventilation

TABLE 1. HEAT PRODUCTION AND WEIGHT OF TURKEYS

POULT AGE WEEKS	WEIGHT EACH POUNDS TOMS	HENS	HEAT BTUH/LB.	PRODUCTION 10,000 BIRD FLOCK MILLION BTUH TOMS	HENS
1	0.26	0.26	28	0.07	0.07
2	0.53	0.47	25	0.13	0.12
3	1.01	0.89	23	0.23	0.21
4	1.64	1.44	21	0.34	0.30
5	2.5	2.1	19	0.48	0.40
6	3.5	2.9	17.2	0.60	0.50
7	4.6	3.8	15.5	0.71	0.59
8	5.8	4.7	14.0	0.81	0.69
9	7.0	5.7	12.7	0.89	0.72
10	8.3	6.7	11.5	0.96	0.77
11	9.6	7.7	10.4	1.00	0.80
12	10.9	8.7	9.4	1.03	0.82
13	12.2	9.6	9	1.10	0.86
14	13.5	10.4	9	1.22	0.94
15	14.8	11.2	9	1.33	1.01
16	16.1	11.9	9	1.45	1.07
17	17.3	12.6	9	1.56	1.13
18	18.4	13.2	9	1.66	1.19
19	19.5		9	1.76	
20	20.5		9	1.85	
21	21.4		9	1.93	
22	22.3		9	2.01	

rate in cold and adjusted down to improve air quality. Since there are a number of fans in the barn on separate thermostats (and circuits to prevent catastrophic fan shut down) adjustments can be made throughout the bird cycle.

The selection of fan capacity is of utmost importance to both litter condition and supplemental heat requirements!

A large part of this heat is supplied by the birds. The heat production per pound is initially high during the early ages and by 12 weeks and after stabilizes to about 9 Btuh/lb poult. Table 1 gives the heat production of poults, which is largely independent of sex, for a given growth schedule for toms and hens. These data can be converted to equivalent gallons of propane by mutliplying by 24 and dividing by 92,000. Sample calculations are made in the Appendix section C. For the brooder barn with 10,000 eight week old toms an equivalent of 211 gallons of propane are produced by the birds each day.

This is a significant quantity of heat from the birds but not enough to supply the building heat loss and ventilation air. At eight weeks of age no brooders are needed but some producers use them to supply the extra heat needed to make up for ventilation losses. Section D of the Appendix shows how to calculate the supplemental heat requirement which for this case is 37.4 gallons of propane equivalent per day. This must be increased to account for the burner efficiency (say 70%) so that with fuel costing $.50 the daily cost would be $26.71. (Divide by efficiency and multiply by the unit fuel cost.)

Since the birds do not provide sufficient heat to ventilate the barn at a level to maintain litter conditions it is important to limit any extraneous additions of water to the litter.

Table 2

Moisture Content of Air

	Relative Humidity		
Temp.	0%	50%	100%
90	0	.016	.032
80	0	.011	.023
70	0	.008	.016
60	0		.011
⋮	⋮		⋮
10	0		.001
0	0		.0008
-10	0		.0005

APPENDIX A

BALANCE OF ENERGY IN BARN

A. Building Heat Loss

1. Wall loses

$$q_{WALL} = \frac{2 * (W + L) * H * (T_{IN} - T_{OUT}) * 24 \text{ hr/day}}{(\text{wall insulation R-value}) * 92000 \text{ BTU/gal LP}}$$

example:

$$q_{WALL} = \frac{2 * (72 + 186) * 8 \ (70 - 10) * 24}{13 * 92000} = 5.0 \text{ gal LP/day}$$

2. Ceiling losses

$$q_{CEILING} = \frac{W * L \ (T_{IN} - T_{OUT}) * 24 \text{ hr/day}}{(\text{ceiling insulation R-value}) * 92000 \text{ BTU/gal LP}}$$

example:

$$q_{CEILING} = \frac{72 * 186 * (70 - 10) * 24}{23 * 92000} = 9.1 \text{ gal LP/day}$$

3. Perimeter losses

$$q_{PERIMETER} = \frac{C * \text{Perimeter} * (T_{IN} - T_{OUT}) * 24 \text{ hr/day}}{92000 \text{ BTU/gal LP}}$$

example:

$$q_{PERIMETER} = \frac{0.9 * 2 * (72 + 186) * (70 - 10) * 24}{92000} = 7.3 \text{ gal LP/day}$$

B. Ventilation Heat Loss

$$q_{VENT} = \frac{(\text{CFM/lb} * (\text{lb/poult}) * (\text{\# poults}) \ (T_{IN} - T_{OUT}) * 24 \text{ hrs/day}}{92000 \text{ BTU/gal LP}}$$

example: 8 week old toms, 10,000 poults

$$q_{VENT} = \frac{(.25) * (5.8) * (10000) * 60 * 24}{92000} = 227 \text{ gal LP/day}$$

C. Animal Heat Gain

$$q_{ANIMAL} = \frac{(\#\ poults) * (lb/poult)\ (BTU/hr\text{-}lb) * 24\ hr/day}{92000\ BTU/gal\ LP}$$

example: 8 week old toms, 10,000 poults

$$q_{ANIMAL} = \frac{(10000) * (5.8) * (14.0) * 24}{92000} = 211\ gal\ LP/day$$

D. Supplemental Heat Needed

1. Brooding heat

$$q_{BROODING} = (\#\ brooders) * (rating\ BTUH/brooder)$$

example:

$$q_{BROODING} = 0$$

2. Purchased Fuel

$$FUEL = q_{WALL} + q_{CEIL} + q_{PER} + q_{VENT} - q_{ANIMAL} - q_{BROODING}$$

example:

FUEL = 5.0 + 9.1 + 7.3 + 227 - 211 - 0 = 37.4 gal/LP day

E. Alternative Sources of Heat

1. Ventilation management - variation of CFM/lb also varies the amount of fuel to be purchased

2. Solar collectors -

- assume collector is the entire length of the barn
- energy received daily from the sun during Novemeber through March on a vertical surface is between 300 - 800 BTU/sq ft
- assume 400 BTU/sq ft/day is collected

$$q_{SOLAR} = \frac{(400\ BTU/sq\ ft\text{-}day) * L * H}{92000\ BTU/gal\ LP}$$

example:

$$q_{SOLAR} = \frac{(400) * 186 * 8}{92000} = 6.5\ gal\ LP/day$$

3. Heat exchangers

a. Area of heat exchange $= \frac{\text{(minimum CFM)}}{5}$

example:

$$\text{Area} = \frac{(10{,}000)}{5} = 2000 \text{ sq ft}$$

b. Exchanger coefficient = EC (for an ideal heat exchanger)

$$EC = \frac{\text{(minimum CFM)} * \text{(Area/plate resistance)}}{\text{(minimum CFM)} + \text{(Area/plate resistance)}}$$

example:

$$EC = \frac{(10{,}000) * (2000/0.5)}{(10{,}000) + (2000/0.5)} = 3640$$

c. Heat gained

$$q_{H\ EX} = \frac{EC * (T_{IN} - T_{OUT})}{92000 \text{ BTU/gal LP}}$$

example:

$$q_{H\ EX} = \frac{3640 * (70 - 10)}{92000} = 2.4 \text{ gal LP/day}$$

FUEL USE AND COSTS IN TURKEY PRODUCTION - MINNESOTA VS. U.S.

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FUEL USED: MINNESOTA AND U.S.

A survey of fuel types used by MTGA producers indicates the relative reliance on LPG (liquified petroleum gas) and other fuels by turkey producers in the state. The 1982 survey indicates that LPG is presently used by 95% of the Minnesota producers as a heat source. Table 1 indicates similar information on fuel sources used in turkey production in other states based on data from USDA (1976) for production year 1974.

Table 1. Turkey Production and Fuel Sources (1974)

State	Production (10^6 lb)	Rank	Heating Fuel Used: Fuel Oil	LPG	N.G.	Coal
Minnesota	364	1		100%		
California	322	2		6%	94%	
North Carolina	260	3	2%	93%	5%	
Texas	176	4		42%	58%	
Missouri	176	5	2%	98%		
Arkansas	148	6		91%	9%	
Iowa	135	7		100%		
Virginia	100	9	16%	58%	5%	21%

Table 2 indicates the relative heating fuel use, in terms of gallons of propane equivalent used per thousand pounds of production, for several of the top turkey producing states, as given by USDA (1976). The values are based on heating only (fuel oil, LPG, natural gas, coal) fuel sources and do not include electricity or motor fuels. Also indicated in Table 2 is the annual degree days (65°F base) ranges for each state as given in ASHRAE (1970).

Table 2. Heating Energy Used in Turkey Production (1974) and Degree Days

State (Rank)	Fuel Use[1] (Gal. LPG Equivalent / 1000 lb produced)	Degree Days
Minnesota (1)	46.3	8300-10000
California (2)	28.4	1700-5700
North Carolina (3)	12.5	2300-4000
Texas (4)	19.6	1000-4000
Missouri (5)	14.3	4500-5500
Arkansas (6)	13.1	2500-3300
Iowa (7)	26.6	6000-7400
Virginia (9)	18.7	3300-4200

[1]Based on fuel heat content values of 138,500 Btu/gal fuel oil, 91,500 Btu/gal LPG, 1000 Btu/cu ft natural gas and 11,000 Btu/lb coal (eastern bituminous).

Most of the values of heating fuel use for different states as indicated in Table 2 appear to be directly influenced by state climatic conditions. What is not indicated in Table 2 is the relative numbers of birds produced in confinement versus range facilities in each state. Nor are particular practices employed in each state, such as range brooding, which may be more or less energy intensive, defined by the data available used in Table 2.

While the actual fuel use in northern latitude production areas may be reduced through conservation techniques, the use will continue to be weather-dependent. Conservation techniques may be applicable in all geographic locations, but the absolute magnitude of the energy used, as indicated in Table 2, may directly affect the economics of alternatives in different climatic locations.

FUEL COSTS: PAST, PRESENT AND ?

The heating values, fuel unit costs and comparative heating energy costs ($/MMBtu) are given in Table 3, for typical fuels used in the Minneapolis-St. Paul residential area in early January, 1982. The different heat energy costs given in $/MMBtu are relative to the various seasonal efficiencies.

Table 3. Heating Fuel Cost Comparison[1]

Heating Fuel Source	Heat Content Btu/Unit	Cost/Unit	Efficiency	$/MMBtu (Output)
Electric Resistance	3412/Kwhr	$.0383/Kwhr	100%	11.23
Natural Gas (Northern Natural)	100,000/ccf	$.485/ccf	60%	8.08
			80%	6.06
			90%	5.39
Lignite	7,000/lb	$40/ton	50%	5.71
Hard Coal	11,000/lb	$77/ton	50%	7.00
Hard Wood	5,500/lb	$50/ton	50%	9.09
LPG (Propane Gas)	91,500/gal	$.743/gal	60%	13.54
			80%	10.15
			90%	9.02
Oil	138,500/gal	$1.189/gal	60%	14.31
			75%	11.45

[1]Effective date 1/6/82; based on <u>residential</u> lot prices.

Table 4 indicates the past several year's historic heating fuel costs for the Minneapolis-St. Paul area.

Table 4. Historic Twin Cities Fuel Prices[1]

Date	1-28-80	1-7-81	1-6-82	1-6-82 Cost $/MMBtu (input)
LPG Transport Lots	52.60	63.20	48.75	5.32
LPG Residential	62.50	72.20	74.30	8.12
Oil #2 Transport	79.84	96.57	103.67	7.49
#6 Transport	46.63	66.89	69.00	4.63
#2 Residential	97.90	110.90	118.90	8.58
Natural Gas NNG-Residential	.294	.373	.485	4.85
NNG-Commercial	.294	.373	.468	4.68
Electric 2nd Step	0.02552	0.0292	0.0383	11.22

[1]LPG @ ¢/gal
Oil @ ¢/gal
Natural gas @ \$/ccf = \$/therm
Electric @ \$/Kwhr

It is interesting to note the stagnation of the price of propane (LPG) prices during 1982. Current price surveys (March, 1982) indicate that LPG prices are below those indicated in Table 4. Some indications of why this has occurred are suggested by the Minnesota Energy Agency (1980).

Table 5 indicates the 1978 propane consumption by sector as given by the MEA (1980).

Table 5. 1978 Propane Consumption by Sector

Sector	Million Gallons	Percent
Residential	91.3	30
Agricultural	94.6	31
Commercial	90.2	29
Gas Utility	12.3	4
Industrial	10.6	3
Other	8.6	3
	307.6 (28.2 Trillion Btu)	

Table 6 indicates the MEA (1980) projection of the baseline propane demand in Minnesota by sector for the years 1980-2000.

Table 6. Baseline Propane Demand in Minnesota by Sector 1980-2000 (Trillion Btu)

Year	Residential	Agricultural	Commercial	Industrial	Total
1980	10.4	8.5	11.2	2.4	32.5
1985	10.1	9.0	12.7	3.0	34.8
1990	9.9	9.0	14.4	3.4	36.7
1995	9.8	9.3	15.9	3.7	38.7
2000	9.7	9.6	17.5	4.2	41.0

Since propane is typically found in conjunction with natural gas and is also a by-product of the refining of petroleum, Table 7 presents an estimate of the proportion of the propane obtained from domestic gas plant production, domestic refinery production and imports, as given by the MEA (1980).

Table 7. Propane Supply By Source[1]
(Percentage of Total Supply)

	1978	1979	1980	1981	1985
Gas Processing Plant Production	59.7	58.1	55.1	51.6	40.0
Refinery Production	32.6	33.2	34.7	33.7	30.6
Importation	7.7	8.7	10.2	14.7	29.4

[1]From: Butane-Propane News, November 1979

The MEA (1980) indicates: "It is expected that domestic propane supply will decrease as a result of declining natural gas production and the less-rich liquid petroleum content of future gas discoveries. Refinery production should remain proportional to the amount of crude oil refined.

Even so, a worldwide surplus of LPG is expected during the early 1980's. A major reason is the new gas processing capabilities being developed in petroleum producing nations. Some analysts have projected a doubling of processing capacity in export areas between 1978 and 1985, with the largest increases occurring in the Middle East. Until the recent energy price hikes, these countries had simply been flaring or burning off the natural gas and LPG found during oil exploration. Such surpluses could have a moderating effect on propane prices.

The Canadian National Energy board estimates that currently 62 percent of Canadian propane is available for export. By the year 2000 this amount is expected to increase to 75 percent."

The recent price moderation of LPG might be explained by the above rationale. How temporary the price fluctuations are is unknown, and any price forecasting should be viewed cautiously, since it is unknown whether propane importation will be federally limited (MEA, 1980). It is the opinion of this author that propane prices will be adjusted to other traditional fuel energy prices, and will reflect the portable and clean burning characteristics of propane.

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CROP FERTILIZER VALUE OF TURKEY LITTER

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A weed is merely a plant for which there is no economically viable use. However, if we discovered that a certain weed contained a needed nutrient for cattle and could economically be grown and harvested for cattle feed, that plant would no longer be called a weed. It would have economic value. Further, if we now discovered that the same plant had special nutritive values for humans, the demand for the plant would increase its economic value. Thus, it might be bid away from the cattle feeders. And even further, if we discovered economically feasible uses of that plant for medical purposes we would again see an increase in its value.

The point I am making is that as any resource has an increase in the number of economically feasible alternatives for which it can be used, it will increase in value. That is the problem we have faced with oil. Oil used to be referred to as that black icky stuff that plagued farmers in Oklahoma. However, those farmers grew rather fond of that black stuff as we found more and more uses for oil. In fact, we now have found so many uses for oil that we have run its value so high that now some of the resources replaced by oil are now economically viable substitutes. Consider the case of both coal and wood. This country as well as many others is in the process of trying to find economically viable substitutes for oil. And as this is done, the value of oil will decline. We are now seeing evidence of this. We have conserved by switching to automobiles that get better mileage and with insulation to conserve heat. We have substituted coal, wood and paper for oil and oil products and we have encouraged further production of oil to increase competition in order to bring supply more in line with demand.

Let's keep the pressure on oil and consider other alternatives in order to keep the cost of oil down. We are here today to discuss the economic merits of turkey manure both as a heat source and as a fertilizer. Both uses, of course, are energy related and as we can more readily make use of turkey litter we can apply downward pressure on oil prices and upward pressures on the value of turkey litter. Today we are talking about two uses for turkey manure--fertilizer and as a heat source. Remember what happened to the value of our theoretical plant as we found more economically feasible uses for it; it increased in value.

A review of the literature indicated that there is not that much known about turkey litter. There are no consistent figures on the nutrient content of turkey litter or on how much is produced annually. A study conducted by Van Dyne and Gilbertson of the USDA estimated Minnesota turkey manure production in 1974 at 282,222 tons. Minnesota Agricultural Statistics indicates

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A paper presented at the Energy Symposium of the Minnesota Turkey Growers meeting, Little Falls, Minnesota, March 23, 1982.

there were 21.9 million turkeys raised in 1974. That indicates 12.88 tons of litter per 1,000 turkeys raised. Other data indicates that 1,000 turkeys raised should produce about 50 tons of litter. The literature doesn't mention the moisture content of the litter. This is one of the discrepencies. In 1980, 25.5 million turkeys were raised. Assuming 50 tons of litter produced per 1,000 turkeys raised provides an estimate of 1,275,000 tons of turkey litter, or 328,440 dry tons.

Another study from Minnesota estimates 25.17 tons of fresh manure per 1,000 turkeys, which now provides estimates of 641,835 tons of fresh turkey manure produced in Minnesota in 1980. That is the figure I will use in my analysis.

The nutrient content of turkey manure varied as much as did the estimates of production. The analysis should always make mention of the moisture content of the sample being tested. Hilemar of Arkansas estimated a ton of turkey manure on an "as is" basis of 33% moisture to contain 19.4# of N, 47.4# of P_2O5, and 26.8# of K_2. At todays prices of N = .15¢/lb, P_2O5 = .26¢/lb, and K_2O = .11¢/lb, the value of a ton of turkey manure on an "as is" basis is $18.18 as applied to the crop.

Another test from a Minnesota grower, probably on an "as is" basis indicated 27.2 pounds of N, 14.2 pounds of P_2O5 and 18.2 pounds of K_2O per ton turkey manure. This provides an estimate of $9.77 per dry ton.

The "as is" value of $18.18 per ton provides a value of $11.6 million if there were 641,835 tons of manure produced in 1980. If I use the second estimate of $9.77 per ton, the total value is approximately $6.3 million. Value at the barn should consider hauling, storing and spreading costs.

Further research is definitely needed in order to truly realize the value of a ton of turkey manure. Research should be conducted by type of turkey grown, litter type, moisture content and other relevant variables.

Nitrogen value is a big portion of the value of turkey manure. As we deregulate our natural gas production in this country, the price of nitrogen fertilizer is expected to increase. Natural gas is an input into nitrogen fertilizer. One USDA study estimates that the price of nitrogen will increase by 72% when natural gas is deregulated. I believe that study was conducted before the present glut of oil hit the market and reduced prices. However, deregulation will have an impact of nitrogen prices and will increase the value of turkey manure accordingly.

Turkey manure as a fertilizer has its drawbacks. To be truly effective in corn production, it should be applied in the fall and plowed or disced into the soil. Spring application may produce an ammonia germination problem. This implies that turkey manure as a fertilizer has to be stored until a productive use of it can be made. It should be stored properly in order to maintain it nutrient content. Some can be applied as a top dressing to hay crops or can be disced into set-aside acres for next years' production. However, there are many times of the year when turkey manure is not easily used as a fertilizer.

Secondly, I would recommend additional uses of turkey manure. Remember as more uses can be made of a resource, the greater its value. The idea of burning turkey litter seems like an alternative worth investigating. It has merit in that it is a continuous user of litter in the cold season when it cannot be applied as a fertilizer. It would not need to be transported and the burned residue would have a value as fertilizer.

I am advocating an increase use of turkey manure, as a fertilizer, which will require more analytical testing in order to determine its true economic value. And, I would encourage the investigation of its use in other ways such as for heating. The more uses that can be made of turkey manure, the greater its value with respect to its substitutes; in this case, fertilizer and heating energy.

TURKEY LITTER AS FUEL: PROPERTIES AND PROCEDURES

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INTRODUCTION

The successful use of discard turkey litter as a heating fuel will depend on an automated, reliable system for handling the litter, burning it, and delivering the heat to the barn. The critical step in the system is the clean, efficient combustion of the litter, but the other aspects cannot be ignored. The handling of the litter may be determined by the burner, and the burner is closely related to the final heat distribution system. Most turkey barns in Minnesota use make-up air heaters or direct-fired heaters. The burner should be well matched to these types of heat delivery systems to avoid excessive conversion costs.

In order to successfully burn the litter and use the heat, the fuel characteristics of turkey litter must be matched to the types of burners that might be used. Burners may be fairly specific about allowable fuel moisture content, ash content, and fuel particle size and strength. This paper discusses the known fuel properties of turkey litter and how the litter would perform as a fuel in various types of combustion equipment available today.

FUEL CHARACTERISTICS OF TURKEY LITTER

The most important fuel properties of solid fuels are moisture content, ash content, and heating value. Moisture content is obtained by oven drying the fuel. Ash content is obtained by slowly burning the fuel over about 24 hours and recovering the ash. Heating value is determined by burning a sample of the fuel and measuring the heat recovered.

Table 1 gives the results for tests on three individual samples of litter. The samples were grabbed from barns and are not necessarily representative, but do indicate some of the peculiarities of turkey litter. Heating value and ash content measurements were made on both wet and oven-dried samples.

The moisture content of the brooder litter sample is fairly high. This is near the moisture content of recently cut wood. The litter can be dried in a drum dryer, but considerable dry matter is lost in the dryer exhaust in the form of small particles and combustible gases. The dried litter can be compressed into pellets for easier handling at some additional expense.

The dry weight ash contents and heating values are very similar for all samples. The ash content for wood, corn stover, and most other biomass fuels is less than 5% on a dry weight basis. The heating value of litter is reduced in direct proportion to its ash content when compared to other biomass fuels. The heating value of turkey litter depends most strongly on moisture content and ash content. As either of these goes up, the heating value will go down.

Table 1. Results of Preliminary Fuel Tests on Turkey Litter

SAMPLE NO.	1	2	3	4
Description	Brooder Litter	Grower Litter	Grower Litter Prior to Drum Drying	Grower Litter After Drum Drying
WET HEATING VALUE (Btu/wet lb)	4600	4510	3600	5920
WET ASH CONTENT (% wet sample)	13.8	13.1	11.7	27.9
MOISTURE CONTENT (% wet sample)	37.7	19.5	40.9	8.57
DRY HEATING VALUE (Btu/dry lb)	6290	6110	6370	5550
DRY ASH CONTENT (% dry sample)	21.4	19.5	20.5	25.7

The ash left over after combustion of the litter contains the phosphorus, potash and other minerals originally present in the litter. The nitrogen contained in the litter is converted to N_2 and lost in the exhaust. Thus, nearly all of the P and K of the litter is recovered in the ash, but essentially none of the N is recovered. It has been suggested that the ash may be a good source of CDP for turkey rations. This may, however, depend on the details of the combustion process.

The results presented above were arrived at by analyzing "grab" samples of litter, and do not indicate the variability due to location, subflooring, management practices, and time of year. In order to obtain a more reliable statistical basis for planning litter burning systems, the Agricultural Engineering Department of the University of Minnesota, with funding from the MTGA has undertaken a broad sampling and analysis program. Several discard litter samples from various growers will be taken this spring and summer for analysis of ash content, moisture content, and heating value. In addition, chemical analyses of the litter and ash will be made to evaluate the fertilizer value of the materials and to gain information relative to sizing combustion air delivery.

Turkey litter, then, can be made available to the combustion system in one of three forms: (1) loose, undried litter, (2) loose, dried litter, and (3) pelletized, dried litter. Other simple processing such as milling or screening may also be used to prepare the litter for conveying and/or combustion.

SOLID FUEL BURNERS

Many solid fuel burners have been designed and manufactured over the years. Some have successfully burned biomass-type materials, others were specifically designed for coal. The burners that can potentially produce heat at around 1 million Btu/hr can be broadly classified by how the combustion air is brought into contact with the fuel. Three broad classifications of burners that can produce acceptable exhaust emissions are: (1) cocurrent flow gasifier-combustors, (2) swirl type pile burners, and (3) sand fluidized bed gasifier-combustors.

Two examples of cocurrent flow gasifier-combustors are shown in figure 1. A portion of the combustion air (primary air) is blown through the fuel and partially burns the fuel. The partially burned exhaust products are combined with more air (secondary air) to complete combustion in the gas phase. Very clean exhausts are possible with this type of system. The fuel moisture content can be up to about 30% for the downdraft burner and up to perhaps 35% for the sloping grate burner. If the fuel mc gets much below 15%, clinker formation becomes a problem. The fuel must be of relatively large particle size (> 1/4"). with no fines since air must be able to move through the unburned fuel bed without channeling. Heat is recovered by exchanging exhaust gas heat with make-up air. Ash is removed from under the grate. Some designs add the secondary air at a remote location in a jet-type gas burner, but these have not found much commercial success.

In swirl-type combustors, the combustion air comes into contact with the surface of a cone shape bed of fuel. The fuel may be added by an underfeed auger or be blown in with the combustion air as indicated in figure 2. Solid particles of unburned fuel and ash tend to be thrown out to the side and fall back to the grate or directly into an ashpit. Fuel moisture content must be less than 15% in order to maintain a hot fire and clean burn. Excessive ash tends to mask the flame leading to reduced combustion rates and poorer quality exhaust. Ash carryover to the exhaust can be higher than with the cocurrent flow burners. Exhaust quality is generally harder to maintain with this type of burner. Heat is recovered by exchanging exhaust gas heat with make-up air or the firebox is located inside a pressure vessel that acts as a boiler and heat output appears as hot water or steam.

Recently there have been advances in the design and operation of sand fluidized bed combustors that have brought them into prominent consideration as combustion devices. As figure 3 indicates air is blown through a support plate and bed of sand until the sand floats on the air. It is then called a "fluidized bed." After the sand has been preheated the solid fuel is added and is quickly heated by the hot sand and volatilized. The volatilized fuel is burned with the air passing through. Heat is recovered by heat exchange with the exhaust gases and by heat exchange with the walls of the fluidized bed. Temperatures in the fluidized bed must be kept below 1500°F to avoid clinker formation. Fuel moisture contents may range from bone dry to 50% mc and be successfully burned in the device. Particle size is relatively unimportant. Ash content is of little concern; the ash simply mixes with the sand. Ash carryover in the exhaust is a problem and means must be provided to collect the ash particles leaving the fluidized bed. Much more powerful fans are required as the combustion air must be forced through the sand.

CONCLUSIONS

The fluidized bed type combustor offers the best possibility for burning unprocessed discard turkey litter. It is rather insensitive to fuel particle size, moisture content or ash content. Other burner systems will require some sort of pre-processing in order to successfully burn the litter. The pre-processing may include drying and pelletizing. Tests of cocurrent flow burners and swirl-type pile burners using dried and wet turkey litter have indicated that the high ash content of the litter reduces the combustion rates and exhaust gas quality. There is a general lack of information available on the combustion of high ash-high moisture fuels in general, and turkey litter, specifically. At this point no commercial burner systems have performed adequately using turkey litter as a fuel. With sufficient development, however, a successful combustion system utilizing a fluidized bed combustor could be operated as a make-up air heater or as a recirculating air heater for individual barns burning the loose, undried litter.

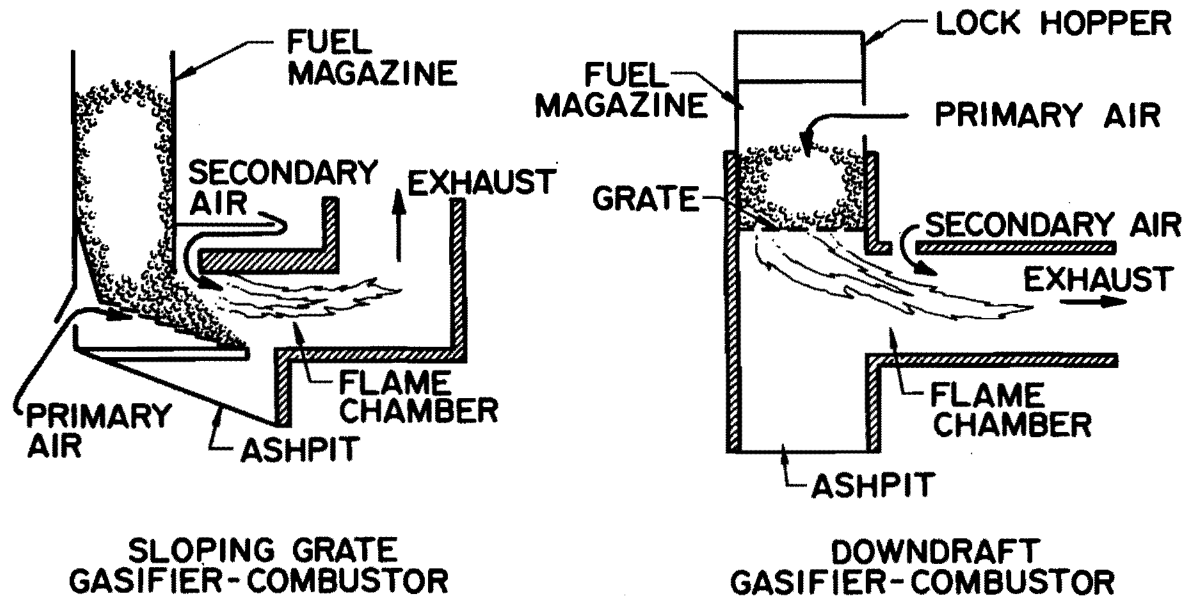

FIGURE 1 COCURRENT FLOW GASIFIER-COMBUSTORS
(Not to Scale)

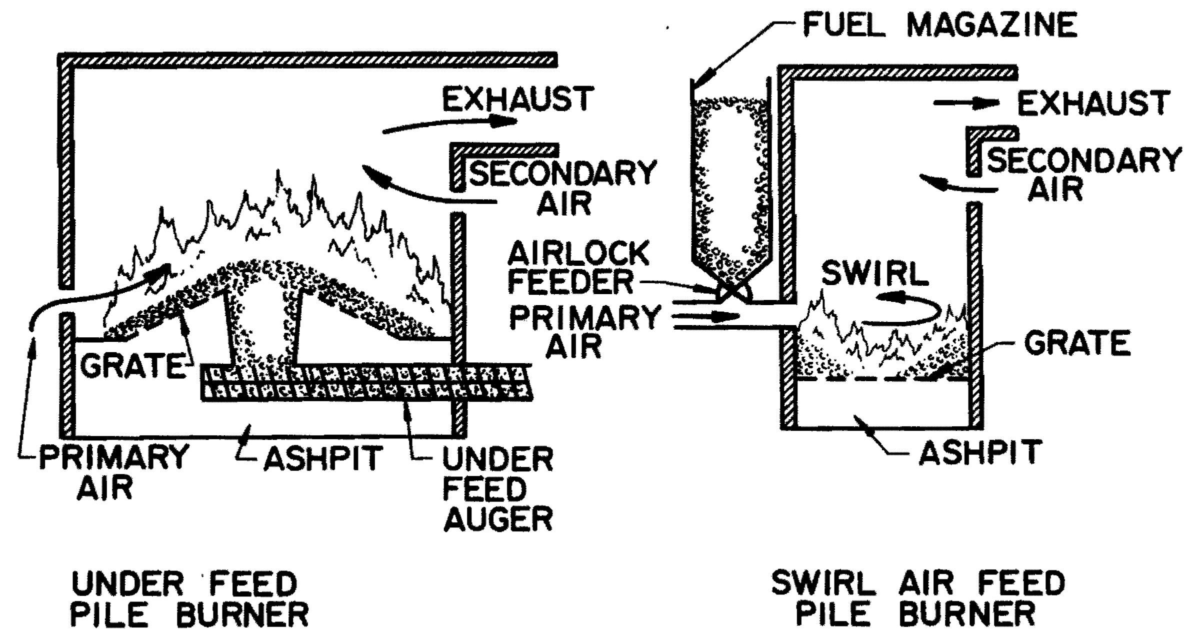

FIGURE 2 SWIRL TYPE PILE BURNERS (Not to Scale)

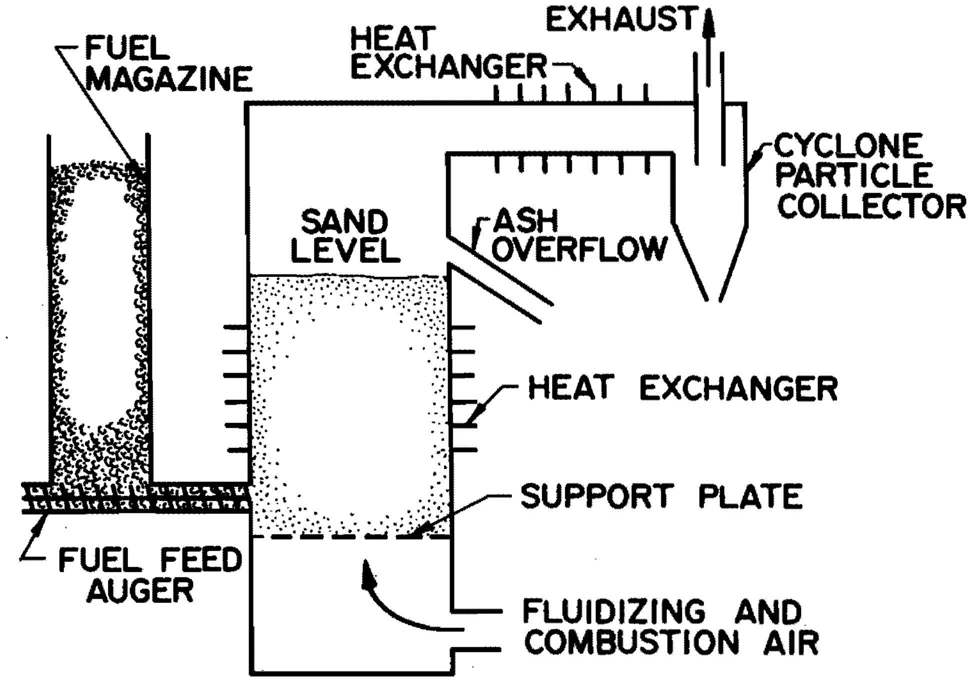

FIGURE 3 SAND FLUIDIZED BED GASIFIER-COMBUSTOR
(Not to Scale)

POTENTIAL OF LITTER ASH AS A FEED INGREDIENT

Paul E. Waibel
Department of Animal Science
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The question has been asked whether the ash remaining following the burning of poultry litter would have value aa a source of nutrients. Unfortunately, research has not been found which would answer this important question.

It seems a fair assumption that whatever mineral elements are fed will appear in the excreta excepting that which is retained by the body or is deposited in products such as eggs.

The feeding of ash should be a clean operation in the sense that any organic compounds would be destroyed and microbial contamination would be eliminated in the burning process. These factors have been of great concern in the feeding of litter or manure.

Not knowing of any research on this subject, I phoned Dr. Tom Sullivan (Nebraska) and Dr. Hardy Edwards (Georgia) for information as they have both studied nutrient availability in ashed materials. As phosphorus is probably the most valuable feed nutrient present, the focus was on phosphorus availability. It was stated that if the phosphorua is in the ortho form it should be available. If it were oxidized to the meta or pyro forms its availability would be poor. Without knowing the truth, it was felt that there is a good chance the phosphorus would be usable. We are presently planning a study of phosphorus availability in feed supplements as part of the bone development project and would be pleased to include some samples of authentic litter ash.

The following calculation was done to determine the capacity of ash to replace conventional dietary mineral supplements. As it was not possible to obtain the mineral content of authentic litter ash, it was necessary to use reported mineral values in litter (assuming that all the mineral would end up in the ash).

The litter composition data:

Component		Blair and Knight (1973)	Chance (1965) Broiler	Chance (1965) Layer	Hileman (1967)	Approx. average	Assumed ash composition
Ash	%	14.1	8.25	19.65	-	10	100
Calcium	%	2.5	1.33	5.56	1.45	1.5	15
Phosphorus	%	1.6	.99	1.09	1.03	1.2	12
Sodium	%	.42			.069	.4	4
Potassium	%	1.77			1.55	1.7	17
Magnesium	%	.35			.42	.4	4
Copper	ppm	23			32	25	250
Manganese	ppm	-			228	200	2000
Zinc	ppm	343			125	200	2000

The mineral supplementation in Department of Animal Science turkey grower diet T-30 follows:

	%
Defluorinated phosphate	2.05
Calcium carbonate	0.60
Salt	0.40
Trace mineral mix	0.10

The following is a comparison of the minerals provided by the mineral supplements in diet T-30 with the minerals provided by litter ash, using the ash composition data derived above. The contribution of phosphorus was made equal for both sources.

Mineral element		Amount of supplementary minerals provided per 100 pounds of diet from	
		Usual diet supplements (total 3.25 pounds)	Ash from burned litter (provided by 3.08 pounds)
Calcium	pounds	0.88	0.46
Phosphorus	pounds	0.37	0.37
Sodium	pounds	0.16	0.12
Potassium	pounds	0	0.52
Magnesium	pounds	0	0.12
Copper	grams	0.091	0.35
Manganese	grams	2.7	2.8
Zinc	grams	2.7	2.8

According to these figures, calcium and possibly salt would need to be supplemented along with the ash to meet the original diet levels. Copper would be 4 times high, but this would not be a problem. A real potential problem is represented by the enrichment of potassium and magnesium in the litter ash. With no potassium supplementation, the diet calculates to 0.91% potassium, while the requirement is 0.40%. With recycling, the potassium (also magnesium) content would build up due to the excessive amounts in natural feeding ingredients.

In conclusion (from limited information), there should be optimism regarding the future use of litter ash for feed nutrients, but quite a bit a research will have to be done to answer questions and solve problems. If potassium and magnesium concentrations build up too much, it might be possible the use the material of higher concentrations as fertilizer and then restart the cycle with "early stage" litter ash. A chemical separation might also be possible if not too expensive.

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BIOMASS HEATING UNITS

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CONCEPT

EFFICIENT BURNING OF SOLID FUELS IN A SPECIAL FURNACE LOCATED OUTSIDE OF AN EXISTING OR NEW BUILDING.

A. NEED
   1. DIMINISHING WORLD LIQUID FUEL SUPPLIES
   2. UNSTABLE POLITICAL CONDITIONS NOT READILY SOLVABLE

RESEARCH AND TESTING

2½ YEARS TESTING WITH UNITS INSTALLED BY DALE'S HEATING INC.

A. APPLICATION
   1. EASTERN COAL
   2. LIGNITE COAL
   3. CORN COBS (15% MOISTURE)
   4. PELLETED WOOD
   5. PELLETED OAT TAILINGS
   6. TURKEY LITTER (LESS THAN 20% MOISTURE)

B. INSTALLATIONS
   1. 40'x 400' TURKEY BROODER BARN
   2. 50'x80' PORTABLE CONSTRUCTION REPAIR SHOP BUILDING
   3. CORN DRYING BIN WITH PORTABLE FURNACE ALSO USED TO HEAT A 50'x50' FARM REPAIR SHOP
   4. SHEET METAL CONTRACTORS SHOP AND WAREHOUSE

INVENTORS CREDENTIALS

DALE FLICKINGER - 27 YEARS EXPERIENCE IN HEATING BUSINESS. 10 YEARS EXPERIENCE WITH COAL AND WOOD FIRED UNITS. 21 YEARS OWNER AND OPERATOR OF DALE'S HEATING INC., SPICER, MINN. INCORPORATED FAMILY BUSINESS IN 1972. SELL, INSTALL, SERVICE ENERGY EFFICIENT HEATING UNITS.

A. SHEET METAL CONTRACTOR
   1. COMMERCIAL
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B. COAL CONVERSION SPECIALIST
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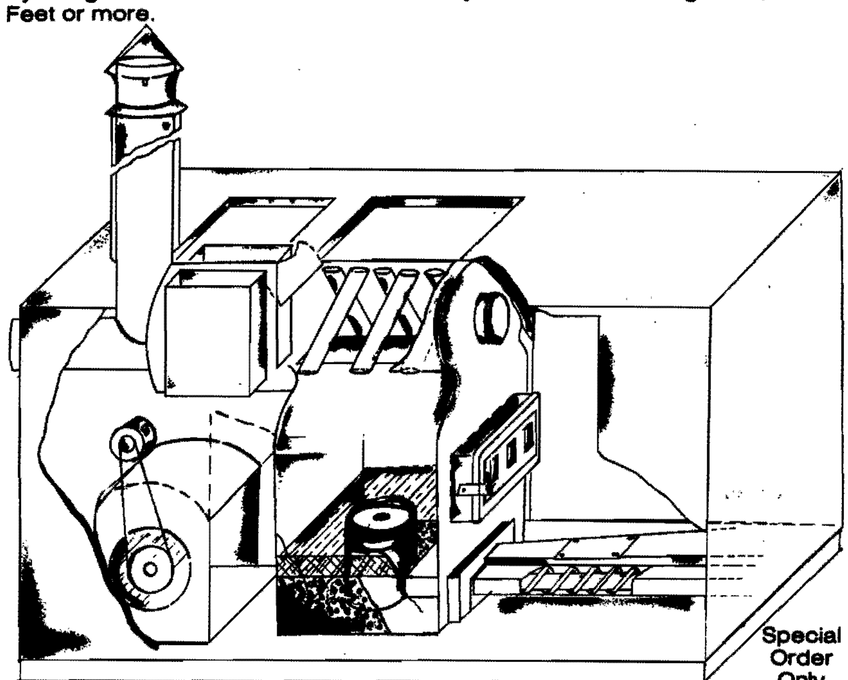
      a. DESIGNED AND INSTALLED COAL CONVERSION OF AUTOMATIC FIRED COAL STOKER UNIT WITH AUTOMATED FLUE CLEANER AND AUTOMATIC ASH REMOVAL SYSTEM.
   2. SWANVILLE TURKEY GROWERS ASSOCIATION - GESSELL FARMS
      a. EFFICIENCY IMPROVEMENT OF PRESENT FACILITIES.

3/12/82

SOLID FUEL SYSTEM FURNACES

COME IN THREE BASIC SIZES:

1. 500,000 BTU Unit that will handle a building up to 100,000 Cubic Feet, if the building is reasonably insulated.
2. 1,000,000 BTU Unit will handle a building up to 200,000 Cubic Feet if the building is reasonably insulated.
3. 1,500,000 BTU Unit will handle a building up to 300,000 Cubic Feet if the building is reasonably insulated.
4. By using a Combination of 2-3-or 4 Units you can heat buildings 800,000 Cubic Feet or more.



COST:	500,000 BTU	1,000,000 BTU	Special Order Only 1,500,000 BTU
RETAIL F.O.B. SPICER*:	$5,908	$8,858	$10,709

*All prices subject to change without notice. Price does not include fans, controls, stokers or holding bins. These will have to be priced according to type of fuel and size of building.

Figure 1. Sizes of furnaces available.

INCREASING PROFITS THROUGH ENERGY OPPORTUNITIES*

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The agricultural sector has been confronting low prices, high interest and rising management costs. While this situation has created significant stress, it also serves as a catalyst for agribusiness operations to determine how to turn adversity into opportunity.

In Minnesota, the turkey growers are also facing competition from the South. With North Carolina growers threatening Minnesota's premiere position in the industry, turkey producers in Minnesota have an extra incentive to develop a comprehensive program that multiplies the numerous opportunities available to reduce costs and develop new profit centers.

REDUCING COSTS

Reducing costs means looking at the management of each operation of business to determine where dollars and cents can be shaved.

The new management is management of efficiency. Peter Drucker's latest says, "We are going to have five very hard years. If we use quick fix thinking, inflation will be dangerous"(1). This suggests the need to look at both short and long term opportunities. Solutions will have to solve short term problems, but leave the door open for long term opportunity.

Since fixed costs are primarily capital and debt intensive, about the only thing most growers can do is optimize production to cope with fixed costs. If you built ten years ago, you're in better shape than those who built recently. At 5-7¢ per pound (Figure 1), the cost of new construction does not look attractive even to the most aggressive grower; thus, increasing profitability through expansion is no longer the most attractive opportunity.

The name of the game now is efficiency. More bird out for less dollar in. To tighten up on efficiency, a grower must look to reducing variable costs. The amount of feed, fuel and litter purchased can also affect short-term interest payments, so reducing these costs will lower overall costs even more.

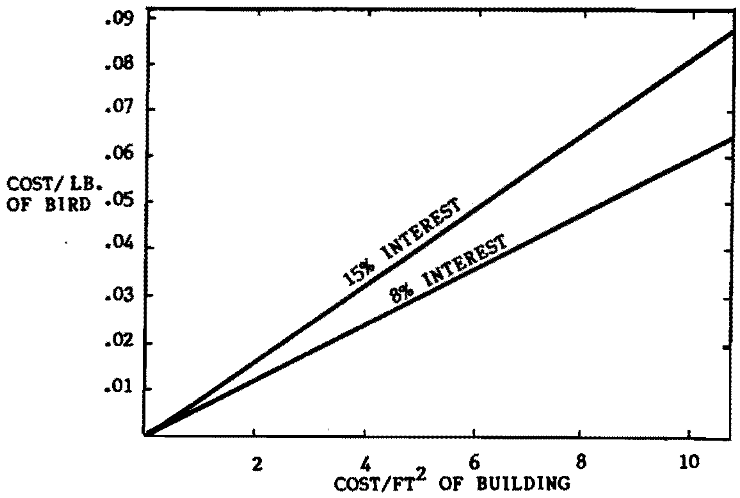
FUEL/ENERGY

If fuel represents an average of 2¢ per pound of bird grown, then a 50% reduction in fuel use on a 3 million bird operation represents a $30,000 increase in profitability.

***Presented at the Minnesota Turkey Growers Association, Energy Symposium, Little Falls, Minnesota, March 23, 1982.**

FIGURE 1

EFFECT OF BUILDING COST ON COST/POUND OF BIRD RAISED
($20\#/FT^2/YR.$)



FIXED BUILDING COST AS COST/LB. OF
BIRD RAISED FOR DIFFERENT INTEREST RATES

$COST/FT^2$ BUILDING	INTEREST RATE	
	15%	8%
2	$ .016	$.010
4	.032	.020
6	.050	.030
8	.064	.040
10	.080	.050

Sure, but what are the costs, one asks? The ideal opportunity is to reduce energy costs by 30% and more without affecting other cashflow.

How can this be done?

CONSERVATION

Traditionally, the least cost, highest return method of saving fuel dollars has been conservation. Most growers have done what they can to tighten up buildings to reduce heat loss, through weatherstripping and insulation. Opportunities that have worked in other livestock facilities have found turkeys to be a rare bird. Ventilation air heat exchangers can save from 30-50% in hog farrowing barns. Dust is the biggest problem in turkey barns, though, and reduces the effectiveness of the heat exchanger. So far, no one is marketing a low maintenance heat exchanger for turkey buildings, though there are some that show promise.

More efficient, ceramic brooders are being marketed in the South that show fuel savings from 30-55% in brooder operations. Their effectiveness lies in radiating more of the heat down, reducing heat stratification in the building. Their effectiveness in Minnesota will probably be more on the order of 10-15% due to different management of buildings and heating needs.

One low cost - no cost means of reducing fuel bills is to tune up propane brooders. Removing dirt and cleaning combustion ports can improve fuel efficiency by several percentage points.

ALTERNATIVE FUELS

Alternative fuels represent the greatest opportunity. Several fuels, when compared against the cost of propane would show an immediate cost reduction of 50% and more (see Table 1). To use them efficiently though, one would have to make a significant capital investment. Coal, wood, and litter represent the most abundant and cheapest of the fuels available to the Minnesota turkey grower today.

Coal, while it does not come from Minnesota, is already seeing increased use by many growers. At $35/ton, coal represents a reduction of 55% in fuel costs compared to propane at 60¢/gallon, and 35% compared to propane at 40¢/gallon.

Wood is an abundant Minnesota resource. It also represents a resource that many growers can develop for themselves, through hybrid aspen plantations. Wood can be burned to provide energy in the form of gas, hot water, or hot air. And wood can be burned in numerous systems that are available today and that can be adapted to many different management needs.

Wood itself can be purchased for anywhere from $15/ton for green chips to $50/ton for wood pellets. Depending on the choice of combustion system, wood fuel can be 50-70% cheaper than propane. Wood fuel systems can provide clean, even heat, with a minimum of labor or maintenance and they are available now.

TABLE 1

COST COMPARISON OF ALTERNATIVE FUELS FOR HEATING

FUEL TYPE	COST/UNIT	FUEL COST/MBTU	COMBUST EFFICIENCY	DELIVERED FUEL COST/MBTU
Electricity	$ .05/kwh	$14.64	100%	$14.64
Fuel Oil	1.20/gallon	7.14	70%	9.28
Propane	.60/gallon .40/gallon	6.52 4.34	75%	8.15 5.43
Natural Gas	4.00/1000 $ft/^3$	4.00	75%	5.00
Corn	2.50/bushel	3.53	75%	4.41
Wood Pellets	50.00/ton	3.12	75%	3.91
Coal	35.00/ton	2.69	70%	3.50
Wood Chips (green)	15.00/ton	1.87	65%	2.52
Litter	10.00/ton	1.25	55%	1.81
Wood Pellets Bought (Litter Sold)	40.00/ton	2.50	75%	3.12

Litter is another abundant resource for turkey growers to consider for fuel. It is low-cost and for some is a disposal problem. Litter is not a natural fuel though, so special combustion systems will need to be developed to take optimum advantage of the opportunity. This could mean two to three years before litter combustion becomes a commercial reality. In the meantime, costs continue to rise and maybe there is a shorter term solution with a long term opportunity.

Litter, besides having fuel value, also has fertilizer and feed value. For those with land, the fertilizer potential is well developed and the current value established between $4 and $10 per ton.

Feeding poultry litter to cattle has been practiced for years by individuals in the South. It is now being looked at by the feed industry as a lower cost feed additive. Values are not well established, but $50-100 per ton for aspen litter as cattle feed is a figure cited by the University of Minnesota (2). This represents 3.1¢ - 6.2¢ per pound of turkey grown and presents opportunities for new profit centers if the right markets are found.

The feed value of litter presents an opportunity in that many feed mills are also producing wood fuel pellets. A delivery of wood fuel pellets for combustion in the turkey houses could result in a pickup of litter to be back-hauled to the feed mill. This opportunity is attractive in that it solves the immediate energy problem of many growers. Installing wood pellet combustion systems can reduce fuel costs immediately by 30% and more. Back-hauling litter also helps relieve some growers of a litter disposal problem, and the purchase buy-back of wood-litter provides incentives for both parties to keep costs down and profitability high.

LITTER VS. WOOD

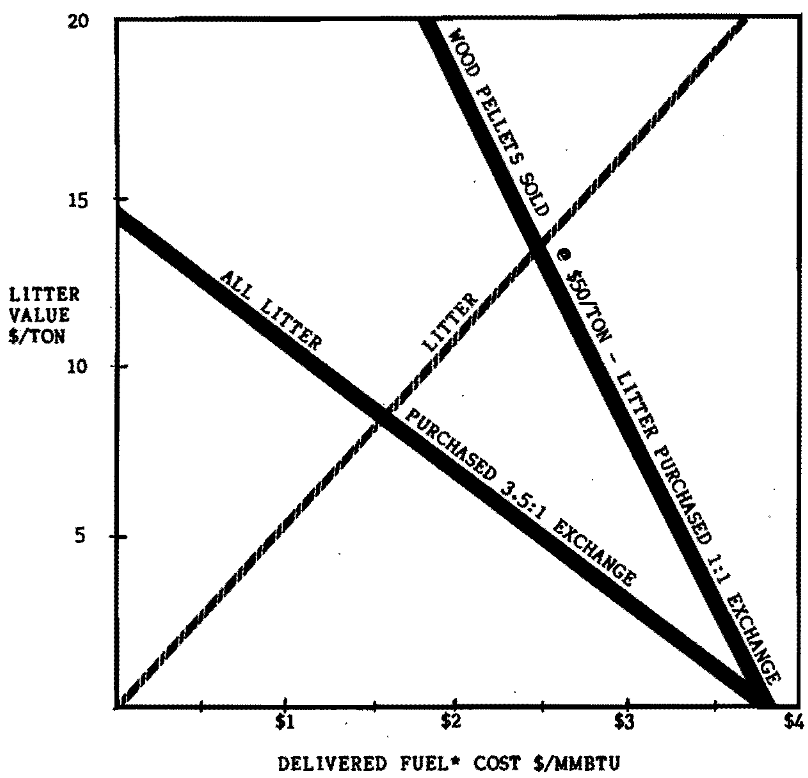
Figure 2 compares the value of litter as fuel versus the trade-off of using wood and selling the litter. Two opportunities are presented. One shows the fuel cost of wood pellets if they are traded on a ton for ton basis with litter. In reality, a turkey producer will have roughly 3½ times as much litter, by weight, as fuel pellets required. The second opportunity then shows the net cost of fuel if all the litter is exchanged for fuel pellets.

Basically, what the figure shows is that if one can obtain $15 per ton for the litter, on a ton for ton basis, he would be better off selling litter and burning wood. If all the litter was exchanged for wood pellets, a 3.5:1 litter for wood exchange, then the grower would effectively receive free wood at $14.25/ton, and at $8.50/ton would be better off selling litter and buying wood.

The graph obviously does not account for the time factor involved in obtaining litter combustion systems, nor does it account for feed handling and storage problems that litter can present. Thus, subjectively, one would come out ahead by moving immediately to wood, even if $8-10 per ton was the going rate for litter.

FIGURE 2

VALUE OF LITTER AS FUEL VERSUS EXCHANGE OF LITTER FOR WOOD PELLETS AS FUEL



*Assumes litter at 4,000 Btu/lb. and 55% combustion efficiency. Wood pellets at 8,000 Btu/lb. and 75% combustion efficiency.

A PROGRAM FOR INCREASING PROFITABILITY

Table 2 represents typical energy costs for a 2.8 million bird complex consisting of two 25,000 square foot brooder barns and two 40,000 square foot grow-out barns. The farm estimates the costs are divided equally between growing and brooder operations. A few points to note about these figures: 1) Fuel use is based on tank fillings and not on actual use. 2) The six summer months use roughly one-half the amount of fuel as the six winter months. 3) The average fuel costs are 2¢ per pound, with summer at 1¢ per pound and winter averaging 3¢ per pound.

Compared to propane at $.60/gallon

With propane at 60¢ per gallon, the annual fuel bill here is $52,000. On the average, the farm uses 7,200 gallons of propane a month, or $4,320.

Purchasing wood pellets to replace 85% of the propane (some propane would still be required in the brooders) would require 425 tons of pellets per year. At $50 per ton, this would cost $21,000 and result in a net fuel savings of $23,000.

To burn the pellets, however, will require the installation of a wood combustion system. With automatic fuel handling and control, hot air heat exchangers and the like, the system can be purchased and installed for around $35,000. Annual payments at 17½% would be in the neighborhood of $11,000 over five years. Thus, total annual cost for the new fuel system would be $32,000 (see Table 3). Assuming 15% of the propane would still be used in brooders, the net savings is around $12,000 per year, a 23% reduction.

If the litter buy-back option is included, assuming one ton of litter can be hauled back for each ton of pellets brought in and litter is purchased for $10 per ton, the net cost for the fuel is reduced to $40 per ton. Thus, fuel savings would be increased by an additional $4,000 per year to over $16,000. This represents a two year payback, the approximate time that will be required to get a litter combustion system on the market.

It should be noted here that the equipment can also be leased. A lease arrangement under terms available today would lower annual payments from $11,000 to $9,600, plus leave a 10% energy tax credit available to the grower.

Compared to propane at $.40/gallon

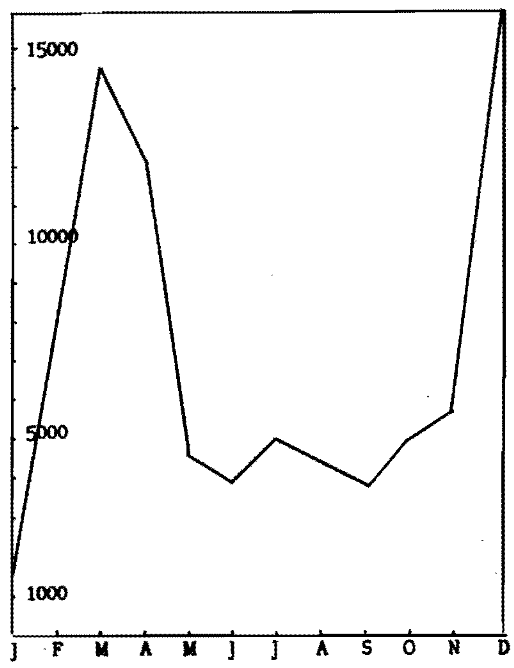
Some growers can purchase propane at $.40 per gallon. The economics of just the wood pellet option compared to propane at these prices is not attractive, though it is close to a break-even option. With no litter buy-back, the system would show a negative savings of $2,800. If a lease was obtained, the loss would be reduced to $1,100 (Table 3).

When the litter buy-back is examined, the economics look more attractive. If one ton of litter at $10 is exchanged for one ton of pellets at $50, the net savings is $1,440 per year. If all the litter can be sold, an

TABLE 2

TYPICAL FUEL USE FOR 2.8 MILLION BIRD TURKEY COMPLEX [From (3)]

MONTH	GALS. OF LP FUEL
January	1,700.
February	8,300
March	14,150
April	12,200
May	4,500
June	3,750
July	5,200
August	4,350
September	3,700
October	5,150
November	5,650
December	18,100
TOTAL	86,800



Cost @ \$.60/gal. = \$52,080
Cost @ \$.40/gal. = \$34,720

TABLE 3

SUMMARY OF ANNUAL COSTS FOR WOOD PELLET FUEL SYSTEM, WITH WOOD AT $50/TON

DESCRIPTION	COMPARED TO PROPANE AT	
	60¢	40¢
NEW SYSTEM		
Loan Payment (17½%, 5 Yrs.)	$11,070	$11,070
Fuel Cost - 425 Tons @ $50	21,250	21,250
Propane for Brooders (13,020 Gals.)	7,800	5,210
NET COST	40,120	37,530
PRESENT SYSTEM		
Propane Costs	52,080	34,720
NET SAVINGS	$11,960	$(2,810)
NET SAVINGS UNDER LEASE SCENARIO*	$13,450	$(1,100)

*Leasing the equipment is a viable option that would reduce the annual loan payment to between $8,970 and $9,580, depending on the quality of the customer. This is based on 5 year terms available today with a 5% buy-out option at the end.

exchange of 3.5 tons of litter for one ton of pellets, at $10, the savings is on the order of $14,700. This is a payback of under 2½ years.

Thus, the analysis shows that compared to propane at 60¢ per gallon, the switch to wood can take place immediately and show positive cashflow and swift cost recovery, even without considering the sale of the litter. At 40¢ per gallon of propane, the return is more dependant on the sale of litter to offset capital costs. With a 1:1 exchange of wood for litter, the system does show a slight positive cashflow, and represents a significant cash savings if all the litter can be exchanged for wood.

SUMMARY AND CONCLUSIONS

Current propane and wood fuel costs over the next few years clearly point out the near term opportunity of an immediate increase in profitability for the grower who switches to wood. This is particularly true if the grower contracts to sell litter simultaneously.

The rapid payback allows the operator to make the decision to switch to litter combustion should a viable system come on the market within the next two years. Or, the grower could maintain the wood system until such time as a litter system would increase profitability over the use of wood.

A program which uses wood fuel and sells litter makes sound sense from three critical areas, technology, management and economics:

- Technology – The systems are here today and are proven. They are easy to use and maintain and are relatively trouble free even in winter.
- Management – The wood system can be adapted to current management programs and rearing practices without significant additional work or learning of new techniques.
- Economics – Wood provides immediate returns with significant increased profitability even with additional capital investments. In the long term, it provides opportunities for even greater cost reductions and increased profitability.

Wood provides the opportunity today without impairing future opportunities of either reduced propane costs or the use of litter for a fuel. Thus, it is an immediate opportunity with long term benefits.

TABLE 4

SUMMARY OF NET ANNUAL FUEL COSTS WITH WOOD PELLETS PURCHASED AT $50/TON AND LITTER SOLD AT $10/TON (PROPANE AT 40¢/GALLON)

DESCRIPTION	EXCHANGE OF LITTER (TONS) TO WOOD (TONS)	
	1:1	3.5:1
NEW SYSTEM		
Loan Payment (17½%, 5 years)	$11,070	$11,070
Fuel Cost (425 tons @ $50)	21,250	21,250
Propane for Brooders (13,020 Gals.)	5,210	5,210
SUBTOTAL	37,530	37,530
Sale of Litter	(4,250)	(17,500)
NET COST	33,280	20,030
PRESENT SYSTEM		
Propane Costs	34,720	34,720
NET SAVINGS	$ 1,440	$14,690
NET SAVINGS UNDER LEASE*	$ 3,150	$16,400

*Leasing the equipment is a viable option that would reduce the annual loan payment to between $8,970 and $9,580, depending on the quality of the customer. This is based on 5 year terms available today with a 5% buy-out option at the end.

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THE USE OF PELLETIZED BIOMASS FUELS

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The use of pelletized biomass fuels in the poultry industry has proven benefits over the use of lignite coal. Lignite coal, which has a wide range of moisture contents, has an unpredictable BTU output making optimum performance difficult. Pelletized biomass fuels are very uniform in BTU output and have a low moisture content. This simplifies the task of tuning equipment for optimum efficiencies.

In addition, pelletized biomass fuels can be stored and handled with conventional farm feed equipment, thus lowering initial equipment investments. One of the biggest problems of solid fuel handling in Minnesota, freezing in the bin, is eliminated with the pelletized fuels, which flow from hopper bins much like any feed product.

A variety of pelletized fuels are available today, including sunflower hulls, wood wastes, oat hulls, and other crop residues. The competition between fuel producers has made pelletized fuels one of the best fuel buys on the market today. Reliable suppliers of pelletized biomass fuels makes the task of energy management simpler and more cost-effective than any product known.

RECLAIMING WARM AIR IN POULTRY BARNS -
YOUR BIGGEST RESOURCE

Wayne Cummings
Forest Fuels Inc.
1024 Washington
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"In the two-plus years we have used the new coal stoking hot-air furnaces, we have reduced our energy costs between 50-60%." Mr. Charles Shafer, grower and manager of the Washington Fryer Commission.

Many growers in Washington are brooding chickens by using re-heated room air only. A typical grower in Washington raises 19,000 birds in a 40' x 150' room at 90°, with outside air at 0°. A complete copy of Mr. Shafer's report is available from this writer.

The equipment used is a standard, production line, heat exchanger-stoker combination with explosion proof motors, 2 special dust inspection cleanout doors, and no filters. The units are capable of burning coal or biomass pellets interchangeably.

The extensive testing and use by many growers in many barns in Washington should make this attractive to Minnesota turkey growers. The furnaces are flexible, simple to assemble, and operate and can even be made to be portable. Because they are standard production units, their cost is very competitive. They are available in 150, 250, and 450 MM BTU units. Boiler systems are also available.

Unlike some stoker systems, these units burn without the formation of troublesome clinkers and can be equipped with automatic ash removal systems. This greatly reduces labor costs and provides the ultimate in convenience for the grower.

This space equipment can be leased or purchased. Fuel contracts with guaranteed prices are available.

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