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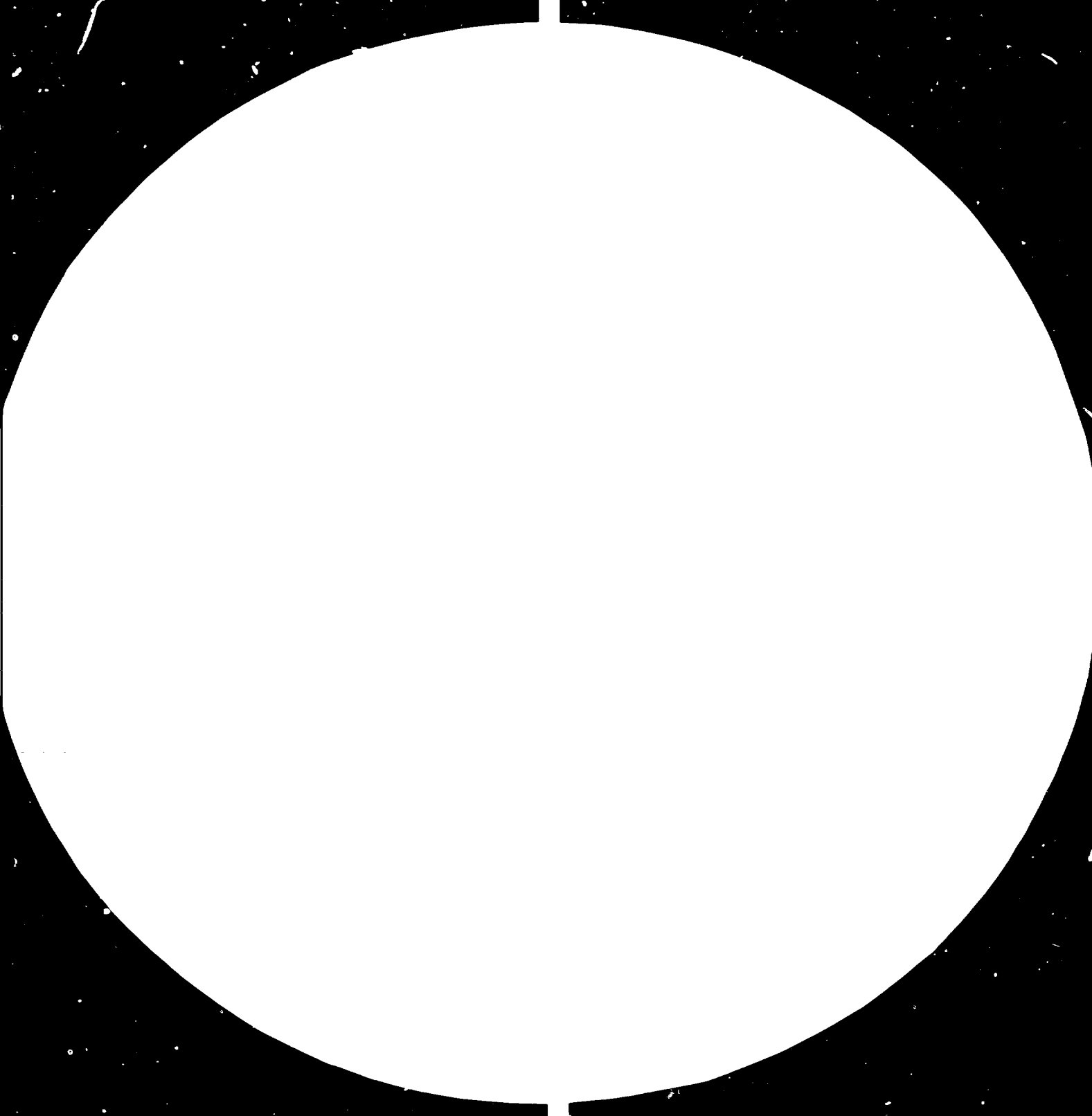
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Resolution Test Chart (NBS 1963-A) showing patterns for 1.0, 1.1, 1.25, 1.4, 1.6, 1.8, 2.0, 2.2, and 2.5 cycles per millimeter.

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A SUMMARY OF THE ECONOMIC BENEFITS OF PRODUCTION AND UTILIZATION OF BIOGAS
AT DE-YANG COUNTRY HORTICULTURAL FARM*

prepared by

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Chengdu Biogas Scientific Institute
Ministry of Agriculture **

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** Beijing, China

As a part of the agricultural and farm livestock production cycle it is possible to make full use of organic wastes such as manure and straw. By means of anaerobic digestion their stored energy can be released as fuel in the form of biogas. This extension of rural energy resources has an important economic value.

This has been demonstrated at De-yang County Horticultural Farm, Sichuan Province, a small model farm producing mainly milk and fruit. There are 160 milk cows and over 21,000 fruit trees. Since 1974 they have used cow manure as a raw material to produce biogas and they have shown that the integrated utilization of biogas has given favourable economic results.

1. Appropriate Biogas Technology

Over a period of several years ten biogas digesters have been commissioned with a total volume of 1,630 m³ and ranging in size from 60 to 300 m³. Two 60 m³ digesters are round, the remainder are rectangular.

Digestion has been carried out in a normal manner and without heating apart from a trial heat exchanger system on one 60 m³ digester which uses waste heat from a diesel generator set. Construction cost per cubic metre capacity is 10 yuan on average. Normal operation has been achieved with these digesters and the yearly average production rate of biogas has been 0.2 m³ per m³ digester volume per day.

Production of biogas at this farm is characterized by a rational overall construction arrangement with an integrated biogas utilization system. The farm is located on a hillside and siting of digesters has been determined according to geomorphological conditions and according to orchard requirements for fertilization and irrigation. In addition, digesters are positioned centrally relative to the milking sheds, water tanks and the biogas power stations. The milking sheds and water storage tanks are higher up the hillside than the digesters, which in turn are above the orchards on the lower slopes. Thus cow shed manure can be flushed with fresh water by gravity flow into a manure feed tank and hence into the digester. Digested slurry is released from the digester by opening the outlet sluice and this then flows along the hillside automatically to irrigate and fertilize the orchards. Electricity generated from the biogas is used to pump water into the 1,700 m³ water storage tanks. There is also a gravity feed sprinkler irrigation system direct from the tank which provides controlled irrigation

for an area of 100 mu. Gas from the digester is also supplied through iron pipes to a dining hall generator and to an ice factory. Over 70 % of the domestic and power generating needs of the farm are provided by biogas.

2. Outstanding Economic Results

Biogas is a multi-functional energy resource and De-yang County Horticultural Farm has been able to provide a large quantity of manure so that integrated utilization of the biogas has produced outstanding economic results.

2.1 Demand for the domestic and production fuel requirements at the farm have been met. At present, three collective dining halls (supplying 340 customers) and all the milk sheds use biogas. Coal has been completely replaced and the use of biogas represents a saving of 120 tons of coal which would cost 4,200 yuan per year and would require transportation labour of 700 man days per year.

2.2 Biogas can be converted to electricity and used to provide motive power. If it is used to drive an internal combustion engine coupled to a generator then utilization of the agricultural by-products will reduce electricity consumption and avoid difficulties associated with provision of a power supply. Farms where agricultural wastes are available as raw material for digestion are perfect sites for biogas plants. By using just the locally available wastes, raw material costs are kept cheap and there is no collection problem. Farms which adopt this will have an independent energy source, will decrease their oil consumption, reduce their processing costs and generally promote their stability and independence.

De-yang County Horticultural Farm set up a small biogas generator station in October 1976 and subsequently 6 KW, 12 KW and 50 KW diesel sets were installed with a total engine rating of 118 horse power. Cumulative power generated to the end of 1979 was 55,340 KWH used mainly for water pumps and lighting. The whole farm is 50 % self sufficient for electricity at night and in addition provides light to nearly six production brigades in over 200 homes.

For modification of these compression ignition engines for biogas utilization a method proposed by Sichuan Provincial Farm Machinery Scientific Institute has been adopted. This is easy and cheap, requiring only a simple biogas-air mixer. The original machine is otherwise

unchanged and the system is safe and reliable. Savings in diesel oil consumption are over 70 %. The above institute has successfully run these diesel engines on biogas with savings of up to 95 % of diesel oil consumption.

Electricity generation cost per KWH at De-yang Horticultural Farm is only 40 % of the cost of electricity from the state network supply. Over the past three years overall savings on electricity have been 12,000 yuan. Also by using biogas as fuel they have saved 16,610 kg of diesel oil.

3. Labour Savings

Since introducing the gravity feed to the digester together with gravity discharge of digested effluent to the irrigation channels for the orchards, much less labour has been required for carrying fertilizer and water. This reduces the work load and saves on labour costs. Since 1975 an estimated 30,000 working days have been saved.

Table 1. Cost per KWH generated using a 4125 A diesel generator set

<u>Combustion Type</u>	<u>Cost per KWH (yuan)</u>
Diesel only	0.1254
Biogas/diesel mix	0.0599
Biogas only	0.041

Note: cost per KWH includes labour, fuel oil, lubricating oil and machine maintenance.

4. Extension of Production Operations

This farm has broadened its production activities since it increased supply and also labour efficiency has been promoted. Farm income has been increased by setting up a battery factory and an ice factory. These sidelines represent 38.4 % of the farm's current production value. Thus through the integrated use of biogas De-yang Horticultural Farm production has been developed. Electricity and fuel expenditure savings are about 33,000 yuan. Savings through a decrease in farm workers and staff expenditure are over 4,000 yuan. The farm went into the red in 1973 but in 1978 and 1979 it showed profits of 6,000 and 37,000 yuan respectively. The total production value in 1979 was 123 % of that in 1978 and over twice that of 1973 before biogas was introduced.

De-yang Horticultural Farm is now designing a development programme which will further integrate biogas utilization and promote modernization. Over the next two years the number of milk cows will be increased and it is planned to build an 800 m³ biogas pit. Through increases in biogas production and improvements in its utilization it is expected to raise the farm's level of self sufficiency for electricity to 80-90 %. In addition, other potential of biogas digester operation will be developed such as using the biogas digester residues for feeding fish. It is expected that this new level of biogas utilization will show further outstanding economic benefits.

Table 2. The effects of oil saving from driving diesel machine with bio-gas

Model	KW/HP	Starting date of operation	Total operating hours(hr.)	Generate (KWH)	Oil saving rate(%)	Statistic date
1105(bio gas only)	6/10	1975,5,	3377	18538	95-98	1979,12,
2105	12/20	1978,1,	982	6688	70-75	1979,7
4125A	50/68	1976,10,	1183	29825	70-75	1979,12

