APPENDIX 5

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APPENDIX 5

Methodology for Estimating the Operating Cost of Machinery

This Appendix describes the methodology used to calculate the average hourly running cost of tractors, harvesters and agricultural implements, and presents the results of the values calculated for 1997. It was clear from the outset that it would be unrealistic in present circumstances for the WUFMAS field staff to make these estimates at farm level, and the first phase review had revealed that "normative" values were far from reality. The methodology for calculating the operating costs of machinery is quite complex, so the explanation given in the 1996 WUFMAS report is repeated here, with correction of some mistakes that occurred there.

The hourly running cost of farm machines has fixed and variable components. **Fixed components** depend on the life of the machine or the duration of ownership and normally include depreciation, interest on investment, tax and insurance, and the cost of providing security and shelter. In the CARs, the financial costs can be discounted at present and in most cases, the capital in security and shelter may be seen as a sunk cost. The recurrent cost of security is better treated as a component of the farm overhead cost. Only the depreciation needs be taken into account and there are several methods to calculate it. The **variable components** of operating cost are fuel, lubricants, spares, maintenance, and labour. These are difficult to estimate at financial prices because:

- spares, fuel and lubricants are being bought for cash on the free market, some bartered for farm products at widely variable exchange rates reflecting local supply and demand, and some are available to some farms at subsidised rates through the state order system;
- some spares are being taken from abandoned machinery, and manufactured locally or in the farm workshop;
- mechanics who maintain the machines and fabricate parts mostly are being paid in kind rather than cash, and quantities are not fully recorded.

Some of the following generalised comments do not apply to mounted and trailed implements that have no motor, but the principles apply nonetheless.

Depreciation

At present, second-hand machinery is not normally traded, but this could change in some republics quite rapidly. Old machinery is written-off the accounts but lies derelict in the machinery yards to be "cannibalised" for spares. In these circumstances, the simplest and most appropriate method is "straight-line" depreciation between the purchase price as new and the write-off value as spares, taken here as 10 percent of purchase price. The equation is:

$$\text{Annual depreciation (US\$/year)} = (P * 0.9) / L$$

where P is purchase price new and L is duration of the life of the machine. This value divided by the average annual use of the machine in hours gives the contribution to the hourly running cost. Alternative methods (declining balance and decremental depreciation) would need to be used in individual cases where

- the machine will be replaced or sold before it reaches its scrap value, or

- when a commercial financing package, combining periodic repayment of capital and interest, is used to purchase it.

Interest and Inflation

Interest, as a function of purchase price, mostly is not paid at present and no effective rate exists for agriculture in the CAR. Were a market to develop then account would need to be taken of whether the farm is

(a) borrowing the capital, and if so, the repayment terms (fixed annual payment or reducing with declining balance), or

(b) the farm is buying the machine out of capital reserves.

Since the farm could have used the money in another way, the interest would be the opportunity cost of investment. Inflation also needs to be taken into account and in western countries for some years the prevailing interest and inflation rates have fluctuated together, maintaining an almost constant differential of 3 percent annually. This net annual interest rate (NIR) would normally be charged but in the CAR inflation is quite high and interest effectively nil so that the NIR is negative. An arbitrary rate of minus 5 percent is used here, which reduces the operating cost of the machine. However, its inclusion would only be relevant in the context of resale of the machine or much use of parts from it to defray the cost of buying new parts for other machines. This latter case is significant at present so operating costs for WUFMAS 1996 are taken to include NIR but both are given in Tables A5.1 and 2.

Fuel Consumption

Most motorised farm machines use diesel as their energy source. Diesel consumption is a function of engine maximum power output (engine size) and the loading on the engine by the work being done. “Norms” for fuel consumption in Soviet literature seem low by comparison with western values, perhaps reflecting a lower proportion of heavy work. Fuel cost makes an important contribution to total running cost of motorised machines so that consumption under different working conditions needs careful estimation. WUFMAS has been unable to obtain realistic values at farm level, so that the approximation (derived from Whitney, 1988) has been used for the present:

$$\text{Diesel consumption (l/h)} = 0.003427P_{max}U + 0.0279P_{max} - 0.006269P_{max} + 0.7363$$

where P_{max} is the maximum power rating of the pto (power take-off) in hp, and U is the percentage utilisation of P_{max} for the work being done.

Lubricants

The main lubricant is oil, costed separately from grease, which is assumed to be included with maintenance cost. As with diesel, objective estimate of consumption is difficult to make so that an approximation (from Whitney, 1988) has been used:

$$\text{Oil consumption (l/h)} = 0.02169 + 0.000431P_{max}$$

where P_{max} is the maximum power rating at the pto in hp.

Spares and Maintenance

For the reasons given above it has been impossible for WUFMAS to make an objective estimate of the financial cost of repairing and maintaining machines on the farm. Much of the cost would be imputed because labour is not being paid in cash. Again, it has been necessary to draw on generalised estimates from western experience, in which repair and maintenance cost is a function of the purchase price. This is not unreasonable in that spares reflect the lower cost of the machines

manufactured in the FSU than equivalent items in the west. The equation (from Whitney, 1988) is as follows:

$$\text{Repair and maintenance (US\$/year)} = 2 \times C \times k \, (L \times H \times R / 2000)^{e} / L$$

where C is the purchase price of the machine when new in US$, k is a constant and e an exponent, the values for which vary with the class of machine as shown in Annex tables. L is the expected life of the machine in years; H is the annual average machine use in hours; and R is the ratio of average actual speed of tractor compared with the typical speed for that type, assumed here to be 0.8, on account of the older design of mounted and trailed implements used in the CAR. Some new tractors and implements are being imported, partly as aid from western countries, but as yet, these are few in number on account of cost. The resulting estimate has not been reduced by 20 percent as in 1996, to reflect the difference in the labour component of machine maintenance cost between Europe and the CAR.

Labour for Operating Machines

This item takes account of the driver of the machine plus any permanent attendants who ride with it to assist with opening gates, adjusting settings and observing the operation of the machine and, exceptionally for example, feeding seed potatoes or seedlings manually into a planter or refilling seed and fertiliser hoppers. It does not include field manual labour, separately recorded by WUFMAS, nor labour used during repair and maintenance, the cost of which is included with the estimate shown above. The daily cost for the driver has been taken as US$2 and for the assistant as US$1. There are regional differences but labour is a small component of total cost.

Price of Fuels and Lubricants

Price of fuels, petrol and diesel, and lubricating oils is subsidised to a greater or lesser extent in all CARs. Prices in mid-1997 at prevailing exchange rates are given in Table A5.1.1.

Table A5.1.1 Price of Diesel Fuel and Lubricating Oil (US$/litre at 1997 prices)

Product	Kazakhstan	Kyrgyzstan	Tadjikistan	Turkmenistan	Uzbekistan
Exch. Rate to US$	75	17	750	5000	80
Diesel	0.24	0.29	0.80	0.11	0.30
Engine oil	0.53	0.65	0.68	0.38	1.13
Gear oil	0.80	1.12	1.13	0.45	1.56

Running Cost of Tractors, Implements and Other Machines

The operating cost of machines with motors is much greater than that of implements that are attached to them. The cost of labour associated with the machine or machine combination is added to the cost of the motorised unit rather than the implement. The cost of any unspecialised labour that works with the implement is included within the measure of general labour required to produce the crop.

The detailed calculation of hourly running costs of tractors and harvesters for Uzbekistan is given in Table A5.1, calculated for heavy, light and average work rates, corresponding to 80, 20 and 40 percent of maximum power rating respectively. The corresponding costs for implements are shown in Table A5.3, and for other motorised farm machines and vehicles in Table A5.2.

Table A5.4 summarises the average running costs of tractors and self-propelled harvesters in each republic, reworked from Table A5.1 on the basis of the average

cost of fuel and lubricants. The effect of fuel pricing policy of different republics is clearly evident in the wide range of price for an hour's use of a tractor. Using the example of a medium-size, tracked tractor it ranges from US$6.1/h in Turkmenistan to US$25.1/h in Tadjikistan. There is also a big variation in hourly operating cost between different classes of tractor, from $5.2/h for a small, wheeled tractor to $26.8/ for a large, wheeled tractor of Russian origin in Uzbekistan. The equivalent machines of western origin are even more costly, since a large, wheeled tractor of USA origin costs $33.5/h, 25 percent more expensive than the Russian machine.

Table A5.5 shows the combined costs by type of implement and the appropriate tractor. There are too many individual combinations to be able to process all so that operations have been grouped into six classes:

1. primary land preparation, including land levelling and ploughing, and occasionally preparation of field canals;
2. seedbed preparation,
3. sowing and operations on the growing crop;
4. harvesting (defined strictly as cutting, mowing, lifting and combine harvesting only);
5. post-harvest operations, mostly carting from field but including also raking, windrowing, baling and crop eradication, and
6. other machine work.

These are the unit rates used to calculate the variable cost of machinery in the gross margin analysis (Section 12). Average prices for the main types of agricultural machinery operation are summarised in Table A5.1.2.

Table A5.1.2 Average Price of Types of Machinery Operations in Crop Production

Type of operation		**Tractor**					**Implement**
	Work rate **ha/h**	**Kazakhstan**	**Kyrgyzstan**	**Tadjikistan**	**Turkmenistan**	**Uzbekistan**	
		Operating cost in US$ per hour					
Land preparation (1^o tillage)	1.4	13.7	15.4	32.8	9.3	15.8	0.6
Seedbed preparation (2^o tillage)	2.6	7.8	8.8	18.4	5.3	9.0	2.1
Crop operations	3.9	5.0	5.5	11.4	3.5	5.7	4.6
Harvesting	1.7	5.3	5.9	12.1	3.7	6.0	3.0
Post-harvest operations in field	2.6	5.9	6.5	13.5	4.1	6.7	5.4

Type of operation	**Kazakhstan**	**Kyrgyzstan**	**Tadjikistan**	**Turkmenistan**	**Uzbekistan**	**Overall**

Of course, individual farms may vary in the particular combination of tractor and implement used for specific operations, due to the availability of equipment, prejudice and perhaps ignorance of the real operating costs incurred. It must also be noted that these prices by local standards must seem high and unrealistic. The reason for this is that much of the cost is not a cash transaction but includes large components of barter and imputed cost. Crop products and livestock are frequently bartered for

spare parts and fuel. Mechanics like other farm labour are not being paid in cash but in kind. They use parts from derelict machines, their skill with the lathes and other equipment available in the workshops and a great deal of ingenuity to fabricate parts and keep machines running. Repairs and wages therefore are mainly an imputed cost. There is no mechanism for financial management, so although most machines were long ago written-off in the farm accounts, it seems most unlikely that they will be replaced in the immediate future.