

8. 添 付 資 料

◦ 農業機械整備マニュアル

MANUAL AND MAINTENANCE STANDARD
OF AGRICULTURAL MACHINERY

SRI LANKA - JAPAN RURAL DEVELOPMENT
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BY D. B. NIYANGODA A. I. MACHINERY
M. NUMATA JAPANESE EXPERT

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- DEWAHUWA -

INTRODUCTION.

A role of agricultural machinery in raising agricultural productivity is a very important one as a agricultural sector is modernized. Nobody will deny, referring to the example in most of the developed countries, that mechanization in agriculture was a driving force in modernization of agriculture as a whole, by which traditional villages cast off into modern villages.

Agricultural machinery, being a driving force to a mechanized agriculture, should be properly maintained and kept always in best condition, and properly used in order to attain a most economical and effective result in their works, and to attain a longest durability.

We hope that this manual will give essence of maintenance, regulation and preservice of agricultural machinery to people who are engaged in this field, and that it may play an important role of help for mechanized farming in Sri Lanka.

CHAPTER I.

HOW TO USE ENGINE PROPERLY.

1. OIL FILL-UP TO THE CRANK CAST.

At the time of oiling the engine should first be set horizontally, and oil be filled up to the indicator line just above the oil gauge. Oil should be properly chosen according to the prescribed viscosity.

2. OIL FILL-UP TO THE AIR CLEANER.

The same quality of oil as that of engine oil should be precisely filled up to the oil level indicator line.

3. COOLING WATER.

Use clean water, fill up, and close the cap firmly.

4. FUEL SUPPLY.

Fuel should be supplied through the filter net without fail, always be careful that water is sometimes mixed in the fuel.

5. FUEL FILTER CHECK.

Check carefully the fuel filter, and if there collect dust and water, at the bottom of filter, clean up completely.

6. CHECK OF THE PULLEY TIGHTENING NUT IN THE MAIN PULLEY.

Check, and if the pulley tightening nut is loose, fasten it tightly.

7. CHECK OF THE TENSION OF THE BELT.

Check and confirm the tension of the belt; push down in the central part of the belt with your finger, it bending should not be excess 20 m/m.

8. ENGINE START.

Put the control lever in the starting position, push the decompression lever, turn the handle, and confirm the sound of fuel jetting. If there is no jetting sound of fuel, loose the air breathing bolts which are installed on to the fuel filter and fuel pump, by turning handle and let fuel jet up untill bubbles disappear. And then tighten the air breathing bolts, push the decompression lever and start engine by 3 - 4 times of inertia.

9. WARNING UP

When engine starts, put back the control lever to the idling position, and keep engine warm up for about 5 minutes.

10. ENGINE STOP.

To stop engine, you have only to put the control lever to the "stop" position. At this time strictly refrain from hasty movement of the control lever up and down, and from moving the decompression lever.

MAINTENANCE BEFORE STRAGE

1. After work, clean off dust and mud clung to each part of the machine and wash with water before you put in the hanger.
11. In case of long term storing
 - a) Draw off the old engine oil from the crank-case and air cleaner, and put new oil.
 - b) Carry out for 5 - 10 minutes an idling operation unloaded so that fuel and oil may go to every parts of the engine.
 - c) After (b) take off all the fuel from the tank. Turn the starting handle and keep engine in compressed condition and confirm the valves are completely closed. This is in order to avoid rust from the valve seats, and you put the machine in the hanger.
 - d) Apply cloth with the machine oil all over the machine. It may prevent from being rusted.

CHAPTER II.

OPERATION AND HANDLING OF 2-WHEEL TRACTORS

1. Oil fill up to the main gear case.

At the time of oiling to the main gear case, the tractor to be kept horizontally on the stand which is provided under the engine mounted chassis.

And the gear oil "#90" be filled up to the oil level mark of indicator. The gear oil should be properly chosen according to the prescribed viscosity.
2. Oil fill up to the rotary case.

Keep the tractor in the horizontal position as above, and fill up the prescribed oil up to the indicated mark.
3. Lubrication for "Sub-chain case" or (Counter-chain case)

Greese has been filled into the sub-chain case prior to delivery

from factory, but high quality grease should be applied after every 50 hours' use.

4. Main Clutch Lever.

It has three "controlling positions". The first is "ON". The main clutch lever is shifted to "on" position when the clutch is engaged, and the power is transmitted through the main clutch to various parts of the tractor.

The second is "OFF". When the lever is shifted to this position, the drive force from engine is cut off within the main clutch.

You should keep the main clutch lever to "off" position before starting engine so that the drive force may not be transmitted to various parts of the tractor.

The third is "Brakes". When the lever is shifted to "brake" position wheels are braked.

Note;

The main clutch lever should be gently operated towards "on" position. If the main clutch lever is shifted hastily to "on" when you are operating the tractor, it may start out suddenly or engine may stall.

5. Speed change lever.

With this lever, the speed can be changed from first to third, and reverse.

The speed change lever should be set at "neutral" position when you start tractor engine.

6. Sub-speed change lever.

There are two speed positions, "high" and "low".

Note:

You should not shift it "high speed" position at the time of reverse when operating on the field. That is very high speed and dangerous.

Refrain from using this speed for any works other than trailer work.

7. Rotary tiller and its speed change lever.

It has two speeds and neutral position. When the lever shifted to "high" position, the revolution of the rotary is fast and soil is pulverized fine. When the lever is shifted to "low" position, the revolution of the rotary is slow and the soil is pulverized coarsely.

Note:

In case it is difficult to shift the lever as mentioned in Paragraph 5, 6, 7, disengage the main clutch lever once, and then try again. It will be shifted easily.

8. Steering clutch lever.

This lever provided by the handle grips of right and left, transmits or cuts the power to the wheels of right and left. For instance, if you grip the right lever, the drive force is cut off in the right wheel, and the tractor turns to the right.

Caution:

When operating up or down steep slope, or driving a trailer refrain from using the steering clutch. You should steer by handle only.

If you steer by gripping this lever under the situation of a steep slope or trailer driving, the tractor turns to the right or left hastily. This is very dangerous.

9. Accelerating lever.

This lever regulates the engine revolutions and power.

You should keep the acceleration lever at "start" position when you start tractor engine.

10. Rear wheel Light adjusting handle.

This handle is for the purpose of adjusting the tilling depth while

in field operation.

When the handle is turned to the right, the tilling depth becomes deep, and when turned to the left, the tilling depth becomes shallow.

11. Rear wheel pipe fitting handle.

The above mentioned the rear wheel hight adjusting handle is for making a slight adjustment in the tilling depth is required. But when deeper adjustment than that, you can get any depth by adjustment this handle.

12. Lubrication:

(a) For various wires.

A few drops of engine oil should be applied to the lubricating holes which are provided on the various wires, such as the steering clutch wires and accelerating wires etc.

(b) Moving and sliding parts.

Before every work, you should apply engine oil to various moving and sliding parts. They can be operated with ease and would not become rusted by lubrication with a few drops of engine oil.

13. Air inflating of tires.

The air pressure of tires should be 1.1 to 1.5 kg/cm² and the same pressure in both left and right tires must be kept. When the pressure of right and left tires are different, the tractor will not go straight forward. Keep the both tires in the same pressure.

14. Tread adjustment and tire change.

Set the magic bar on the rotary shaft or protudent hook of the rear hitch, and lift up the handle. Then the magic bar acts as a support, and one wheel is lifted up from ground. Remove the wheel tube pin and make tread adjustments or change tires.

Note:

When using the magic bar on a concrete floor or hard ground, be careful so that the tip of the magic bar may not slip.

15. Removal and attachment of rotary tilling Unit.

Remove the set belts or set nob of the sub-chain case (or counter chain case). Loosen the rotary hitch bolts setting the rotary and rear hitch, and then pull out the front side of the sub-chain case from the main gear case at the connecting part.

(In case of model KL-781, pull out the sides of the counter-chain case from the rotary tilling unit and main gear case at the connecting parts).

How to attach the rotary tilling unit, the way of which is in the reverse order to the above.

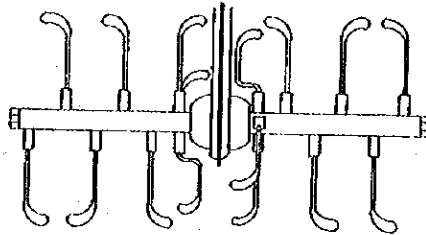
Note:

After removal, be sure to cover the connecting part of the main gear case with a rubber cap. (Model K-550 only).

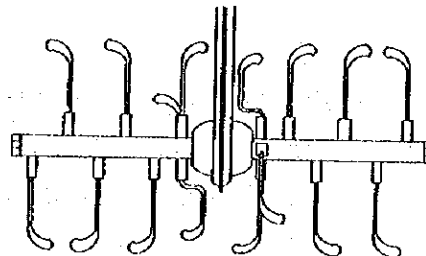
16. How to attach the tilling blades.

The ways of the blade setting are as follows:

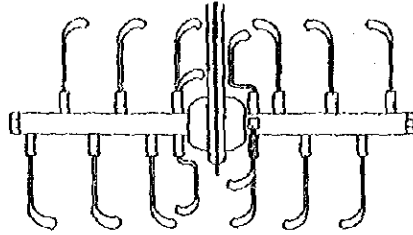
(a) Plain tilling



(b) Out-ward tilling

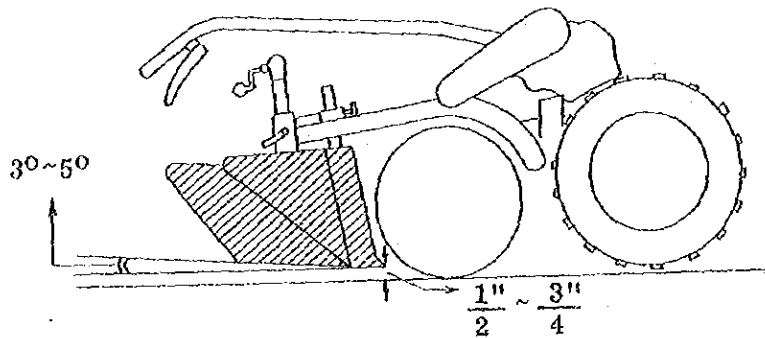


(c) In-ward tilling



17. How to attach ridger and adjustment.

Tilt the tractor forward, insert the shaft of the ridger through the bradkot of the ridger from underneath the rotary tilling cover, and then firmly tighten the ridger setting ball in a correct position. The adjustment of the ridger angle and the height of ridger as shown in the following figures.

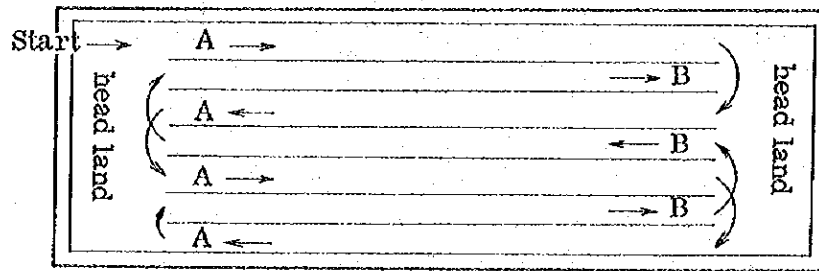


18. Rotary tilling, especially plain tilling.

There are many ways in the rotary tilling, but "every other space tilling method" is the most efficient way. It is the easiest and most popular.

- (a) First till along the band of the partition. Next till the whole field leaving space narrower than the width of the rotary tiller.
- (b) After you finish the above till the space which is left untilled by on the return way. In this case, the wheel will pass over the tilled place, so that tilling depth will be uniform.

- (c) Finally, till the head lands which are left untilled, and then the way is as follows:



19. Ridging.

The tip of the ridger should be set $1/2'' - 3/4''$ high above the straight extended line of the tangent between the circumference of rotary and the circumference of the wheel.

When the ridger is raised higher than this standard position, the ridging becomes shallow. And when lowered, the ridging becomes deep.

- (a) Till by "every other space tilling method" as paragraph 18 - a first. Next, attach the ridge and till the untilled parts, if the soil condition is good. It saves time for ridging.
- (b) But, if the soil is hard it should be ridged after the tilling to over.

20. Cleaning after use and storage.

Be sure to wash off dirt which may have been clung to the various parts. After washing, be sure to wipe off the water and then apply engine oil to the various parts. It may prevent from being rusted if the machine would be stored for a long term.

remarks:

o refill-up # check.

x change + # clean & check, if
defected it should
be replaced.

Item	Checking time					Descriptions
	daily # o	every 50h. # o	every 100h. #	every 100h. #	after seasonal work #	
Cooling water	# o					Check water level and refill up to the designated level.
Crank-case oil	# o	x				Check oil level, the gauge is provided at the rear of engine and if oil level is lower than the central part of the upper and lower notched mark, it should be refilled up to the upper notched mark. If oil is dirty and viscosity has gone it should be replaced with new oil. Engine oil must be changed to new oil every 50 hours.
Fuel filter			+ #	+ #	+ #	Remove the filter every 100 hours of operation, clean impurities on the inside and rinse the filter and filter strainer well with light oil. If strainer is damaged replace with a new filter.
Nozzle				+ #	+ #	Check and clean thoroughly, if there is tendency that out-put has decreased. If the needle is not smoothly moving up and down, it must be replaced with a new nozzle.

Item	Checking time					Descriptions
	daily	every 50h.	every 100h.	every 100h.	after seasonal work	
Oil piping		#			#	Check oil leakage from the piping and the screw of various parts whether loose or not after over 50 hours' use.
Fuel tank					+	Clean the interior of the fuel tank after operation of every seasonal work.
Air cleaner	#	#			+ #	When used in ordinary places, clean with kerosene or light oil. When used in specially dirty places, clean every day, if the oil in side the air cleaner is dirty, replace with new oil.
Grinding of intake and exhaust valves, and valve seats.	#			+ #	+ #	Be sure to clean and check, if it defected it should be regrind properly. And then the valve clearance should be made as following figure when engine is cold and the stroke is set at the top deadcenter of compression position. ISEKI KD-70 & KD-900.28 m/m KUBOTA ER-50 & ER-90)0.2 m/m YANMAR ES & ESC
Valve clearance, intake & exhaust			#			Check valve clearance after every 100 hours' use, if it is not correct, clearance should be adjusted properly. The standard valve clearance should be followed when engine is cold and the stroke is set at the top deadcenter of compression position.

Item	Checking time					Descriptions																												
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						* ISEKI ED-70 & KD-90 0.28 m/m.) Intake and * KUBOTA ER-50, ER-90..... 0.2 m/m.) exhaust valve * YAMMAR ES & ESC 0.2 m/m.) clearance both) are same.																												
Injection pump					#	Check and clean, if the pump is not properly working or out of order, replace with a new pump ass'y.																												
Piston rings					#	Check if there are seizing and wear off of the piston rings. measure the gap between the ends of the ring with a feeler gauge keeping the ring in the cylinder bore. If the gap is over 1.5 m/m. the ring should be replaced with a new one.																												
Bolt and nuts, bearings					#	Check and confirm that all are tight. Tightening torque of bolts and nuts, excluding special bolts & nuts.																												
						<table border="0"> <tr> <td><u>bolt size</u></td> <td><u>torque kg/cm</u></td> <td><u>Nut size</u></td> <td><u>torque kg/cm</u></td> </tr> <tr> <td>M 5</td> <td>30 - 40</td> <td>M 5</td> <td>60 - 70</td> </tr> <tr> <td>M 6</td> <td>60 - 80</td> <td>M 6</td> <td>100 - 130</td> </tr> <tr> <td>M 8</td> <td>130 - 180</td> <td>M 8</td> <td>250 - 350</td> </tr> <tr> <td>M10</td> <td>200 - 300</td> <td>M10</td> <td>350 - 700</td> </tr> <tr> <td>M12</td> <td>500 - 600</td> <td>M12</td> <td>900 - 1100</td> </tr> <tr> <td>M14</td> <td>700 - 800</td> <td>M14</td> <td>1300 - 1500</td> </tr> </table>	<u>bolt size</u>	<u>torque kg/cm</u>	<u>Nut size</u>	<u>torque kg/cm</u>	M 5	30 - 40	M 5	60 - 70	M 6	60 - 80	M 6	100 - 130	M 8	130 - 180	M 8	250 - 350	M10	200 - 300	M10	350 - 700	M12	500 - 600	M12	900 - 1100	M14	700 - 800	M14	1300 - 1500
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	daily	every 50h.	every 100h.	every 100h. after seasonal work															
Belt tensioning	#				Check the bolt tensioning by pushing down the central part of the belt with your finger. If it bends by 10 m/m to 20 m/m, it is correct.														
Set bolts for rotary time	#				Check it before every work, be sure to tighten the bolts nuts securely.														
Lubrication: Main gear case rotary case		# # #			<p>Check oil level every 50 hours' use. If it is lower than the described line, refill with new oil of the same kind. If oil is very dirty or after one year's use, replace with new oil.</p> <p>Qty of filling oil:</p> <table border="1"> <thead> <tr> <th>Model</th> <th>Qty</th> </tr> </thead> <tbody> <tr> <td>KL-781</td> <td>4 liters</td> </tr> <tr> <td>KR-850</td> <td>5.3 "</td> </tr> <tr> <td>K -550</td> <td>4.7 "</td> </tr> <tr> <td>KL-781</td> <td>0.5 "</td> </tr> <tr> <td>KR-850</td> <td>2 "</td> </tr> <tr> <td>K -550</td> <td>1.5 "</td> </tr> </tbody> </table> <p>*main gear case</p> <p>*rotary case</p>	Model	Qty	KL-781	4 liters	KR-850	5.3 "	K -550	4.7 "	KL-781	0.5 "	KR-850	2 "	K -550	1.5 "
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Counter chain case		# x		#+x	Check and apply with new grease.														
Wires, moving joints		#		+	Check and apply engine oil if necessary. Remove all kinds of wires and clean with clean kerosene or light oil after season is over.														

Item	Checking time					Descriptions
	daily	every 50h.	every 100h.	every 100h.	after seasonal work	
Bolts & Nuts	#					Check all the bolts & nuts. If it is loosened you must tight it securely before starting work.
Cleaning	+					Clean mud and dust with clean water after every work.
Storage					+	When machine is to be stored for a long time, be sure to apply new oil after it is cleaned well with water, and close the valve by putting the position at the compressed position. Be sure to drain the cooling water (water cooled engine only)
Tire						Check inflation of tires before use. If pressure is not enough or the inflations of the right and left are different, make the both have the proper and same pressure.

TROUBLES	POSSIBLE CAUSES	CORRECTIVE ACTION
<p>A. Engine does not start in spite that cranking-up is easy</p> <p>a-1. It has no noise of the fuel injection or the noise does not come regularly when you turn up the starter handle several times by hand.</p> <p>a-2. Fuel has water in the tank.</p> <p>a-3. Compression pressure is not enough or less than required when you turn the cranking handle by your hand.</p>	<p>Speed lever is not in the "start" position.</p> <p>No fuel in the tank or there is air in the fuel line.</p> <p>The injection nozzle is not properly working or fuel pump has a defect.</p> <p>Improper valve clearance.</p> <p>Engine-oil is defected.</p> <p>Valve seats are defected.</p> <p>Improper valve timing.</p> <p>Engine head tightening nuts are loosened or head gasket packing is defected.</p>	<p>Set the speed lever at correct "start" position.</p> <p>Fill-up fuel in the tank, and then loosen the air breather bolts which are provided on the fuel filter and fuel pump, wait until disappear bubbles in the flowing fuel, and then tighten the air breathing bolts.</p> <p>Clean the injection nozzle with light oil nicely. In case of defect of parts replace with new parts.</p> <p>Check the injection pump and if it has defect, replace with new parts.</p> <p>Drain off all the fuel from the tank and clean nicely, and then refill with pure fuel.</p> <p>Adjust it properly.</p> <p>Replace with new oil.</p> <p>Regrind and correct them.</p> <p>Adjust it properly.</p> <p>Tighten the nuts securely or replace with new part.</p>

TROUBLES	POSSIBLE CAUSES	CORRECTIVE ACTION
	Piston rings are worn out or broken. Valve spring is broken. Mesh of air filter is clogged.	Replace with new parts. Replace with new part. Clean with light oil nicely.
a-4. Governor trouble	Governor is not in proper action.	Correct it properly.
B. In case cranking up is heavy with the decompression lever	Engine oil is not proper or defected. It is seizing on to the moving joints. Improper tappet clearance or Valves are touching the piston when cranking up.	Change oil with correct viscosity. Clean and correct it, if it is defected, replace with new parts. Adjust it properly.
C. Engine has suddenly stopped itself	Gear is engaged with another. The moving part has caught something.	Take off the engaged gear. Take off the strange material.
	Fuel is just finished. Fuel line has bubbles.	Fill up fuel. Take off the bubbles according to the method in paragraph A.
	Fuel is not a proper kind or water is mixed in the fuel, Over loading. Valve springs break down.	Take out all the fuel from the tank and clean nicely in the fuel tank. then fill up proper kind of fuel. Reduce the load. Replace with new parts.

TROUBLES	POSSIBLE CAUSES	CORRECTIVE ACTION
<p>c-1. Cranking up is heavy inspite of off-clutch.</p>	<p>Engine is over heated & seizing on moving part.</p>	<p>Check up the several moving part, if it is defected by over heating replace with new parts.</p> <p>In case of air cooled engine: check the net of cooling air inlet, if it clog by dust, clean out it nicely.</p> <p>In case of water cooled engine: check up cooling water level, if water level is less than described line, refill up clean water to described line.</p>
<p>c-2. Cranking up is easy at the of off position of clutch</p>	<p>Valves are soized or valve guide is broken.</p> <p>Transmission or Rotavator has trouble</p>	<p>Check up and defected should be replaced with new parts.</p> <p>Check up and correct it.</p>
<p>D. Engine stops when at the slow rotation</p>	<p>Over loaded.</p> <p>Improper valve clearance.</p> <p>Governer is not properly working.</p>	<p>Reduce loading.</p> <p>Adjust it properly.</p> <p>Correct it, if some parts are defected replace with new ones.</p> <p>As paragraph A-2.</p> <p>As paragraph A-3.</p>
<p>E. In case of abnormal sound of explosion.</p>	<p>Water is mixed in the fuel.</p> <p>It is caused as paragraph A-3.</p> <p>Fuel filter is clogged with dust.</p> <p>Fuel pipe is clogged with dust.</p>	<p>Clean nicely and operate.</p> <p>As paragraph A.</p>

TROUBLES	POSSIBLE CAUSES	CORRECTIVE ACTION
<p>F. Out put power of Engine is not sufficient.</p> <p>f-l. Over heating.</p>	<p>Governor mechanism is not properly working.</p> <p>Fuel is not a proper kind.</p> <p>Engine oil is not a proper kind or defected.</p> <p>The cooling air inlet mesh is clogged with dust.</p> <p>The cooling fan is broken down.</p> <p>Fan belt is loosened or broken down.</p> <p>Governor mechanism has improper working.</p>	<p>Check up and makt it properly.</p> <p>It should be changed to proper kind.</p> <p>Replace with new oil of proper kind.</p> <p>Clean it nicely.</p> <p>Replace with new parts.</p> <p>Should be tightened properly or replace with new parts.</p> <p>Check and correct it properly.</p>
<p>G. Engine is hunching</p>	<p>Governor spring is defected.</p> <p>Injection timing is not correct.</p> <p>Valve mechanism has improper functioning.</p>	<p>Replace with new parts.</p> <p>Correct it properly.</p> <p>Check and correct it properly.</p>
<p>H. Engine has irregular knocking sound.</p>	<p>Injection pump is improperly functioning.</p> <p>Injection nozzle is improperly functioning or carbon clings to the nozzle</p>	<p>Check and correct it properly.</p> <p>Check up the nozzle opening pressure and should make 140 kg/cm² or, clean off carbon nicely.</p>

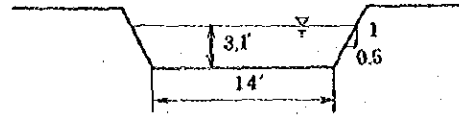
TROUBLES	POSSIBLE CAUSES	CORRECT ACTION
<p>h-1. You hear different knocking sounds when engine rotates. with inertia after you suddenly take back the acceleration lever from the high acceleration position.</p>	<p>Moving parts are defected.</p>	<p>Dis-assemble and repair it or replace with new parts.</p>
<p>I. Fuel consumption is too much</p>	<p>Fuel pipe jointing nuts are loosened. Fuel tank or fuel pipe has a crack same as paragraph A-3. Air cleaner is clogged with dust. Over loading. Governor mechanism is not properly functioning.</p>	<p>Tighten it securely. The crank should be repaired as paragraph A-3. Clean it up nicely. Reduce to normal loading. Check and correct it.</p>
<p>J. Oil consumption is too much.</p>	<p>Oil is leaking from Gasket packings. Oil pipe is cracked. Oil pipe setting bolt is loosened. Oil seal is defected. Oil viscosity is improper.</p>	<p>Retighten the tightening bolts, or replace the gasket packing with new parts. Repair or replace with new parts. Tighten it securely. Replace it with new parts. Replace with new oil.</p>
<p>j-1. The exhaust smoke has white colour too much.</p>	<p>Piston ring or cylinder is worn off, and then the lubricating oil is burning.</p>	<p>Replace with new parts, or cylinder should be bored and then choose an over sized piston and piston ring.</p>

TROUBLES	POSSIBLE CAUSES	CORRECT ACTION
<p>K. Engine is over rotation</p>	<p>Adjusting screw is not at correct position. Smoke set lever does not return properly.</p>	<p>Set to correct position and make it to the designated r.p.m. Check, and make it properly function.</p>
<p>L. Engine rotation does not return to the idling revolutions when the accelerator is returned.</p>	<p>Accelerator cable is rusted.</p>	<p>Clean it or replace with new parts.</p>
<p>M. Oil or smoke is coming out from the breather</p>	<p>Engine oil level is not correct. Some parts in motion are seized etc. Piston-rings are worn out.</p>	<p>Fill up to the described line. Replace with new parts. Replace with new parts.</p>
<p>N. Smoke comes out in a bad colour</p>	<p>Oil viscosity is too low. Compression pressure is not enough. Valve mechanism is defected. Piston ring is worn out. Injection timing is improper.</p>	<p>Refill with new oil. As paragraph A-3. Check and correct it. Replace with new parts. Adjust it properly.</p>
<p>n-1. Excessively bluish</p>		

TROUBLES	POSSIBLE CAUSES	CORRECT ACTION
n-2. Excessively blackish	Fuel is not proper kind. Smoke set-lever is defected. Injection timing is not correct. injection nozzle is not properly functioning.	Drain and refill with a proper kind. Repair it. Adjust it properly. Repair or replace with new parts.

。 水路断面形状について

当国では、現在一般にのり勾配 $\frac{1}{0.5}$ の水路が採用されており、例えば本地区の上流部は右下図のようになっているが、水路はのり面崩壊と流入土砂とによる堆砂がひどく年々それを除去するには多大な労力を要する Blahela, Kalawewo 等の大水路では余裕も大きく問題ないがデワフワ等底巾が「牛の体長」程の水路では深刻な問題である。



現象	原因	対策
1. 土砂の流入	自然的なもの 山側から降雨時の土砂流の流入	ショルダーディッチ及び流入処理工による止水
2. のり面の崩壊	人為的なもの 水路内水流のエネルギー 家畜の渡河、水浴び 人間の渡河、水浴び	流速のダウン、緩やか且つ一様な水路のり面 一般に禁止、プッシュ並木で囲う、水浴渡河の場所を設ける。

これについて説明を加えたい。

上図では、別々の原因として示したが、現実には相互に助長し合っている。

即ち、家畜等の渡河地点の足掛りが起点となり、降雨時の流入水水路内流入が当たって崩壊している。又、降雨時の山側からの流入水は土砂も含むが、それにより、のり面の崩壊が進む事がより重大である。

1. 家畜の等の渡河・水浴対策

現在プロジェクト内には、4.3 mileの間に恒久橋6ヶ所の外丸太橋が18 (4.2ヶ/mile)ヶ所あるにも拘らず、人及び家畜の常習的渡河地点が43ヶ所(535 feetに1ヶ所)もある。この間には護岸工が両側計2,800 ftもあるので、土水路部分に対する密度は更に大きい。これらの地点の多くは、水路内流水、山側からの流入水等による崩壊の起点となり易い状態になっているか、或いは既に崩壊が始まっている。

牛の水浴は法的には禁じられているが現実には無力である。そこでむしろ、積極的に水浴及び渡河のための施設を設けその他の地点はプッシュ及びバラ線で柵を作って物理的に禁じる必要がある。幸い当地区には十分余裕あるリザーブランドを、この目的に使用すべきであろう。

2. 流入水

山側からの流入水については、73年福田技術調査団が来スした際、ショルダーディッチ建設の検討をし、その後サブコミティーでもテストケースとして施工する事の同意を得たが、日本からの供与を予定したセメントの到着が遅れ施工出来なかった事は残念であるが、こゝで再度その構想を述べる。

山側から降雨時に流出する水は承水路でキャッチし直接水路に流入することは防止する。承水路はコンクリート製に限らず、場所によってはブッシュ及び土水路でも十分であろう。

承水路でキャッチした水は、一たん土砂溜りの付いた水槽に落し地形条件により under cross 又は over cross で反対側に流すか、上水のみを用水路に入れる。

over cross の場合は歩道橋も兼ねるとよい。

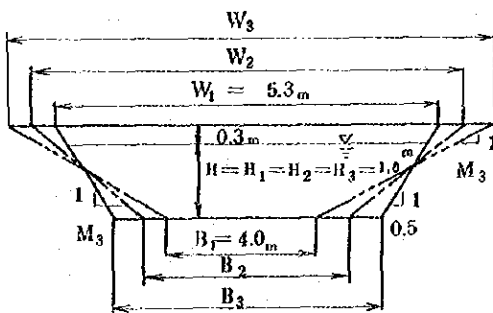
3. 断面

通水断面についてみると、のり勾配の緩いところでは崩壊は起ってはいない。のり面勾配を緩くすれば、用地巾、施工断面、水面蒸発、浸透量の増加等好ましくない現象が起きるが、当地では、用地巾では一般に障害にはならず、水のロスも、他の要因の方が大きいとも云えるので、ここでは、施工断面の増加を検討してみる。

デラフワ幹線用水路程度のものを想定し、水路縦断勾配、流量、水深を一定にし横断面ののり勾配及び底巾を変化させた場合の上巾及び土工量の変化をみる。

便宜上、流量 $2.5 \text{ m}^3/\text{sec}$ 、水深 1.0 m 、余裕高 0.3 m 、粗度係数 0.03 とし、もとの水路の底巾を 4.0 m 、横断面ののり勾配を $1:0.5$ とし、比較断面のそれを $1:1.0$ 、 $1:1.5$ とする。

各断面の流積 A 、巾 P 、経深 R は次頁表の如くである。



一般式	$A = (B + n)H^2$	$P = B + 2H\sqrt{1+n^2}$	$R = \frac{A}{P}$	$R^{\frac{2}{3}}$
S_1	$A_1 = 4.5$	$P_1 = 6.236$	0.7216	0.8045
S_2	$A_2 = B_2 + 1.0$	$P_2 = B_2 + 2.828$	$\frac{B_2 + 1.0}{B_2 + 2.828}$	$R_2^{\frac{2}{3}}$
S_3	$A_3 = B_3 + 1.5$	$P_3 = B_3 + 3.606$	$\frac{B_3 + 1.5}{B_3 + 3.606}$	$R_3^{\frac{2}{3}}$

$$\text{マニング式から } V_1 = \frac{1}{n} R^{\frac{2}{3}} = \frac{0.8045}{0.03} R^{\frac{2}{3}}$$

$$Q = A_1 V_1 \text{ から } 2.5 = 4.5 \times 0.8045 \times \frac{1}{0.03} R^{\frac{2}{3}} \rightarrow$$

$$\rightarrow V_1 = 0.555 \text{ m/s}$$

$$R^{\frac{2}{3}} = 0.02071, \quad 1 - 0.00042$$

$$\text{又、 } A_2 = \frac{1}{n} (1.0 + B_2) \left(\frac{B_2 + 1.0}{B_2 + 2.828} \right)^{\frac{2}{3}}, \quad Q_2 = \frac{1}{n} (1.0 + B_2) \left(\frac{B_2 + 1.5}{B_2 + 3.606} \right)^{\frac{2}{3}} \text{ から}$$

$$(1.0 + B_2) \left(\frac{B_2 + 1.0}{B_2 + 2.828} \right)^{\frac{2}{3}} = (1.5 + B_2) \left(\frac{B_2 + 1.5}{B_2 + 3.606} \right)^{\frac{2}{3}} = 3.62025$$

これより、 $B_2 = 3.54$ 、 $V_2 = 0.551$ 、 $W_2 = 6.14$ 、 $B_3 = 3.15$ 、 $V_3 = 0.538$ 、 $W_3 = 7.05$ を得る。

又、施工断面は各々 $S_1 = 6.045 \text{ m}^2$ 、 $S_2 = 6.292 \text{ m}^2$ 、 $S_3 = 6.630 \text{ m}^2$ となる。

したがって、 S_1 と S_3 の差は 1 mile 当り $(6.630 - 6.045) \text{ m}^2 \times 1,609 \text{ m} \times 0.353 \text{ CB/m}^2 = 335 \text{ CB}$ 、土工単価を 15 Rs/CB とすれば、 $335 \text{ CB} \times 15 = 5,000 \text{ Rs}$

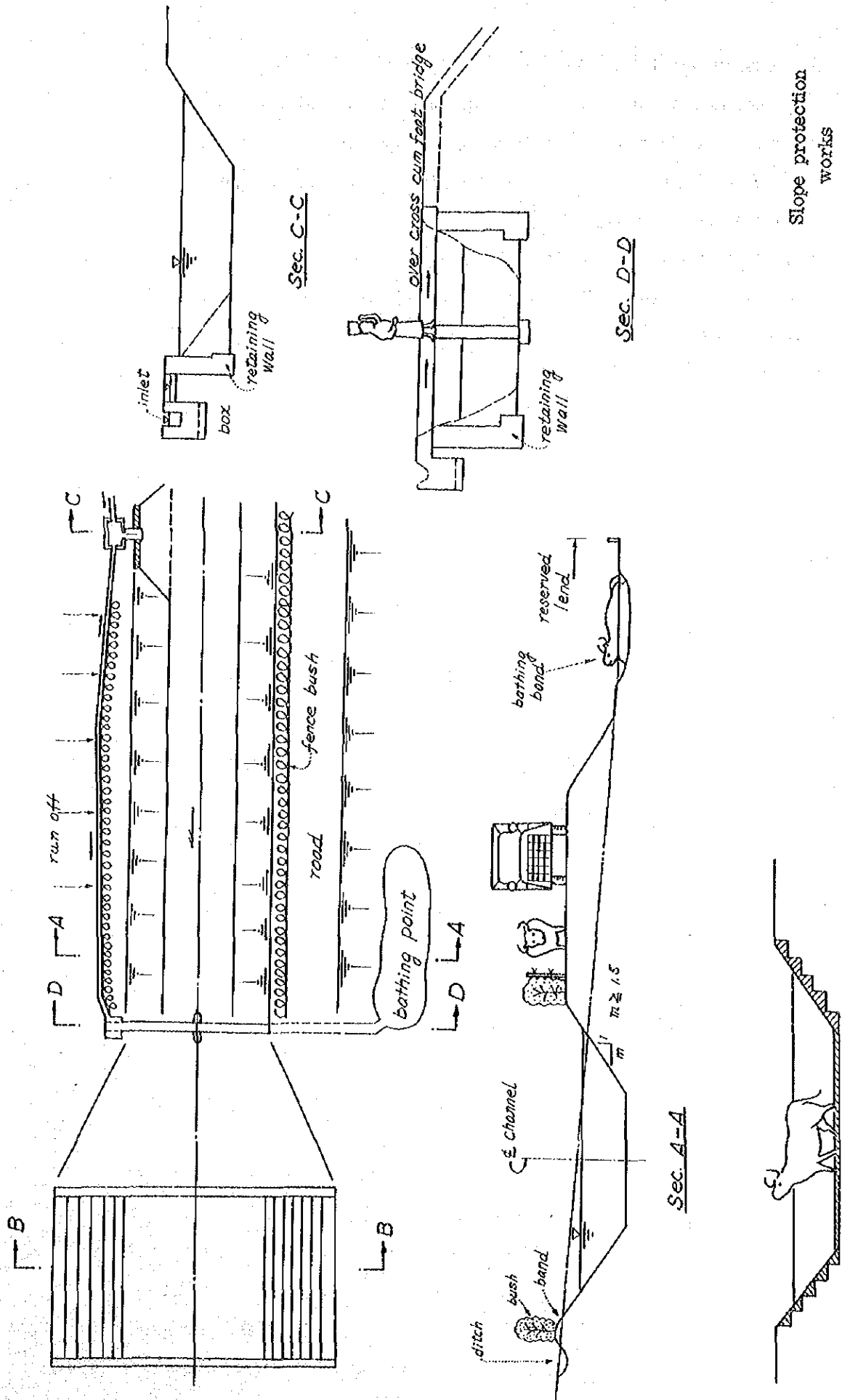
例えば、Dewahuwa について、全水路 9.5 mile では全平均をこの % とすれば $5,000 \times \frac{1}{3} \times 9.5 = 32,000 \text{ Rs}$ となるが、本事業で実施した Disilting の工事費 $49,700 \text{ Rs}$ よりも安い。

よって、土地に余裕のある、比較的緩やかな当ドライゾーンの場合、水路横断面を緩くする検討

以上を要約すれば以下のようになる。

1. 横断面ののり勾配を緩くする。その不可能な所のみ retaining wall を設ける。
2. ブッシュ、土水路を主とした shoulder ditch を設け
3. 承水した水はインレット工により上水を水路に入れるか、歩道橋を兼ねた over cross 或は under cross で反対側に流す。
4. 手を入れないよう道路側にブッシュのフェンスを設ける。
5. 用地のとれる所には渡り場、水浴び場を護岸るして設置する。

これらを次頁に図示する。



Slope protection works in general (proposed)

Sec. B-B

Sec. A-A

Sec. D-D

Sec. C-C

○ 圃場整備工事便覧 (Dewahuwa 地区)

序

この便覧は、1971年から1975年までのスリランカ国Dewahuwa地区での圃場整備実施結果に基づき作成したものである。圃場整備そのものの内容および実施方法が非常に多岐にわたるため、他地区への汎用性を考える場合、その前提条件が明確でなければならないので、この便覧ではDewahuwaでの結果をもとに、次の如く初期条件を規定して、以下各項を記述する。

- 1) 各 allotment 間の境界線は現状のまま変更しない。
- 2) 6 HP 2輪トラクターによる耕耘を前提として区画割する。
- 3) 整地工等主要工事はドルブローザによる機械作業とする。

1. 工種決定

圃場整備の効用と、効用発揮に要する手段は次の如く大別されるので、地区の状況に応じ、必要工種を決定する。

- 農地生産性の向上————→・区画整理と水口統合による用水の有効利用およびTransplanting等栽培条件の整備
・必要に応じて暗渠、客土等
- 労働生産性の向上————→・圃場規模の拡大による耕耘機等農業機械の効率的利用
・圃場への侵入路増設による営農資機材搬入、搬出の改善
- 農地保全性の向上————→・圃場規模拡大による土地勾配の是正
・畦畔および水口の強化による農地保全性の強化

2. 工種基準

2-1 測 量

- ・ レベルおよび平板測量器を用いて、Scale 1/100程度でかつ、1 FT等高線の入った平面図を作成する。
- ・ 標高測定は、傾斜地では50 FT程度、平坦地では80 FT程度のランダムな格子上の各点とし、各標高測定点は、同時に平板測量器で位置確認して平面図上にプロットする。
- ・ 作業効率は、測量隊1編成(測量員1、補助員1、人夫3)につき、15 AC/日程度。

2-2 区画の決定

- ・ 耕耘機の作業効率、田植作業等を考慮して、1筆あたり $\frac{1}{4}$ AC (傾斜部) ~ $\frac{1}{2}$ AC (平坦部)を標準とする。
- ・ 農作業の面からは、正長方形の区画が希ましいが、こだわりすぎて整地土工費が増大する事をさげなければならない。

- ・特に傾斜部では、区画の長辺が等高線に沿うよう区画配置する。
- ・区画短辺長は、30 FTをMin.とし、長辺長は300 FTをMax.とする。
- ・田面標高差Min. 0.5 FT（主として平坦部）、Max. 3 FT（主として傾斜部）の範囲とする。
- ・切土厚、盛土厚とも、Max. 2 FTの範囲とする。

2-3 整地工

- ・90 HP（重量11 ton～12.3 ton）ブルドーザー2～3台を1編成とし、硬盤破砕のためのリッパ付ブルドーザー、また低湿地用の湿地ブルドーザーを、各々必要に応じてこの編成の中を含む事がのぞましい。なお、ブルドーザー1台による単独作業は、事故発生時の処置が難しいので避けなければならない。
- ・片道切押土距離はMax. 150 FTとする。
- ・地形により、機械効率は一定しないが、標準として30 m³/hrの切押土能力および20 hr/ACの機械稼働時間が一般的。従って、1日当り稼働10 hr/台で2台編成の場合、整地工の標準的歩掛りは1日/AC/2台で、稼働日20日/月とせば、20 AC/月/2台となる。

2-4 表土扱い

- ・一般に表土扱いをする事が理想的であるが、実際には工費を考慮して表土と下層土の肥沃度が著しく異なる場合にのみ実施（注、Dewahuwaでは表土そのものの肥沃度が低かったため、表土扱いは行なわなかった）。
- ・表土扱いを行なう場合、その深さは0.5 FTを標準とし、この部分の表土を畦畔予定地に押土堆積してから整地工およびラフな均平作業を行ない、しかる後、再度、表土撤出しを行なう。
- ・表土扱いを行なわない場合の一時的な地力低下に対処するには、V₁混合肥料0.5～1 bag/AC（12.5kg～25kg）を散布するのが有効。

2-5 均平作業

- ・均平作業は最も重要な作業である。作業基準は、平均田面標高に対しその間場内のどの点も土2 inchの誤差の範囲となること。
- ・均平作業の実施方法はDryと水張りの2種類がある。
 - ・Dryの場合は、一圃場内で9～12点の各点標高をレベルでチェックし、ブルドーザー切押土を繰り返して、各点間の標高差を±2 inchの範囲におさめる。
 - ・水張りの場合は、標高チェックの必要はなく、浅い（2～4 inch程度）水張り状態で、水没部、突出部を目測し、主として湿地ブルで切押土して均平状態にする。
- ・一般にDry状態での均平作業は、水張り状態のそれに較べて機械効率が悪い。即ち、AC当り均平に要する機械稼働時間はDryでは、6 hr、水張りでは4 hr程度である。
- ・従って、均平作業時にタンク放水或いは雨水により水張りが可能であり、かつ湿地ブルが使える

る場合には水張状態での均平作業を行なうのが有利である。

2-6 畦畔造成および水口設置

- ・ 畦畔は、重機械による盛土・転圧の Earth making とする。機械作業のため、畦畔の規模は上巾 2 FT、高さ 2 FT と、やや過大なものとなるが、カニ穴を防ぐにはむしろ有効とも云える。
- ・ 転圧は、3.5 HP (重量 3 ton) にて行ない必要な場合、人力転圧を併用する。機械効率 3.5 hr/AC 程度である。
- ・ 田越しの水口は 1 : 3 : 6 のコンクリート製とし、8' × 8' 程度の現場打フリュームとする。なお、呑口、吐口には 4 inch 程度のツバ (cut wall) をもうける。
- ・ 水口設置にあたっては、コンクリートフリュームの底部、側部の土砂を人力にて十分に締固める必要がある。
- ・ 以上の畦畔および水口の設計については、Final Report 本文中の図 4.2.3.3 を参照のこと。

2-7 用排水路工

- ・ 平坦部では、圃場の短辺に沿って用水路、反対側の短辺に沿って排水路を設置し、用水が田越しではなく、直接圃場水路から圃場内に入り、また直接排水路へ排除されるのが理想的である。
- ・ しかし、傾斜部で不用意にこの方式を採用すると、農民による水管理がルーズな場合、用水は圃場水路を徒ちに流下して、圃場内に導かれることなく排水されてしまう危険性がある。
- ・ 従って、工費との関係もあるが、用水の有効利用のためどちらが当該地区に適当か慎重に検討しなければならない。(注、Dewahuwa では、工費、地形条件を考慮して、従来の田越し方式を存続させた)

2-8 道路工

- ・ 営農資機材の効率的な搬入搬出のため、2 allotment に 1 条の割合で農道を設置する。
- ・ 道路規模は造成巾 10 FT とし、路盤工として 4 inch 厚の敷砂利を行なう。
- ・ 道路盛土転圧は整地工と併行して行ない、運搬盛土は行なわない。

2-9 その他

- ・ 低湿地で地下排水が不良な場合は暗渠排水を行なう。深さ 2 FT 程度、間隔 50 FT 程度で圃場内にトレンチを掘削し、ソダ、瓦礫等を埋設後、トレンチ埋戻し転圧を行なう。
- ・ 表土の肥決度が著しく不良の個処では、近傍タンク底地等の腐植土を客土する。撤出し土は地山状態で 1 inch 厚程度とす。

3. 機械管理

前掲のとおり、本便覧は機械化施工を前提としているので、機械の管理は工事推進上、最重要課

題となる。機械使用前、使用中、使用後の管理は次の基準（別添英文）によるものとする。

英文基準

4. 工事費内訳

- 上記各標準値により、AC当りの直設工事費を算出すると次の如くなる。

Main Sob by Heavy Madoine	}	Wages	10人 × Rs 8 =	Rs. 80
		Salary		250
		Diesel oil	50 Gal × Rs 5 =	250
		その他		30
水 口	}	Wages	8人 × Rs 8 =	65
		Concrete	0.25 Cub × Rs 360 =	90
道路その他				35

計 Rs. 800/AC

- 但し、このRs 800/ACには減価償却を含まず、かつ、operator等常勤職員の給与が含まれている事に注意を要する。年間を通して、間場整備工事を行ない、その施工面積を増せば面積当りの給与の占める比率が小さくなるので、この分AC当り単価は廉くなる。

102