# WASTEWATER REUSE 1
# Agricultural use

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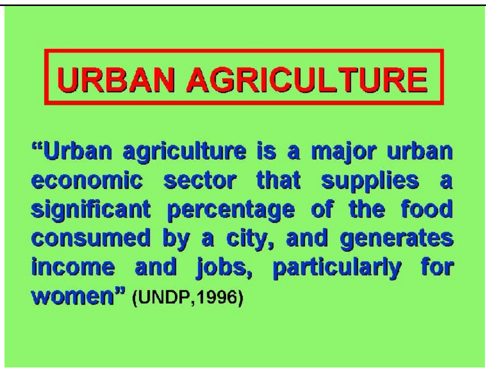
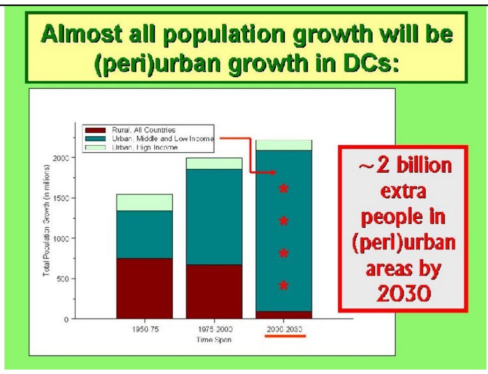
|---|---|---|
| 1. |  | This is the first of four presentations on the use of wastewater in agriculture. |
| 2. |  | 'Urban agriculture' is a very important part of agriculture, but one that is generally overlooked. This quotation from a book published in 1996 by the United Nations Development Programme shows how important it is. |
| 3. |  | And it's important because roughly a third of all households in the world practise urban agriculture in one way or another, and they produce around a third of the food consumed in urban areas, and also because something like two thirds of those working in urban agriculture are women. |
| 4. |  | Over the next 2–3 decades almost all population growth in the world will be urban, but really periurban, areas in developing countries. By 2030 there'll be two billion extra people in these areas, and they will all need to eat. |

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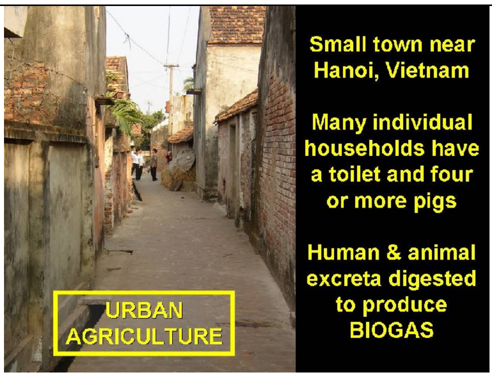
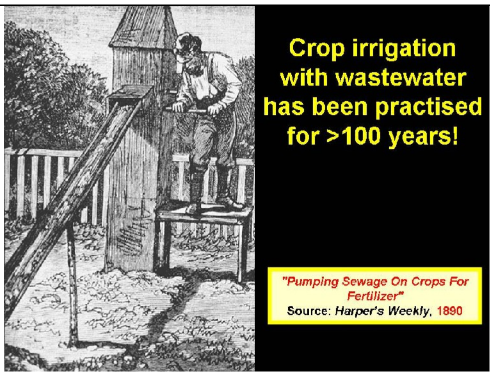
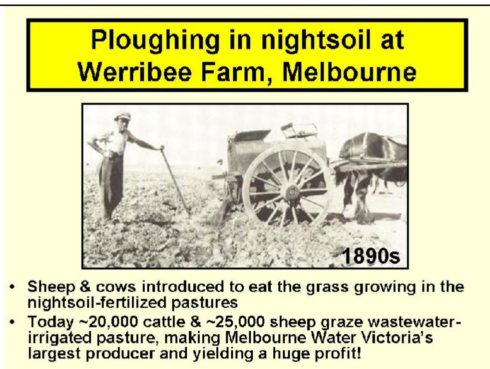
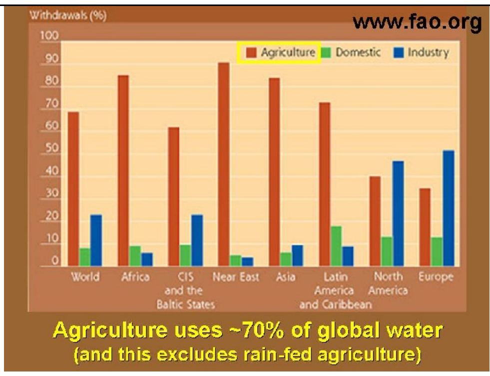
| **5.** |  | This slide shows a lane in a small town near Hanoi in Vietnam. Most households have a toilet and a few pigs. |
| **6.** |  | The human excreta and the pigs' excreta are discharged into … |
| **7.** |  | a biogas digester, and the biogas is collected and … |
| **8.** |  | used for cooking. The digester costs around US$500 and use of the biogas reduces the monthly household expend-iture on energy by about $5. |

<table>
<tr><td>9.</td><td>
</td><td>But the most common use of human excreta in agriculture is the use of wastewater for crop irrigation and, as we will see, only adequately treated wastewater should be used for this.</td></tr>
<tr><td>10.</td><td>
</td><td>This is not something new. It's been done for over 100 years: this photo was published in 1890.</td></tr>
<tr><td>11.</td><td>
</td><td>This slide shows a photograph taken in the 1890s of nightsoil being ploughed into the soil at Werribee Farm in Melbourne, Australia. Today Werribee Farm is Melbourne Water's Western Treatment Plant, but the company still raises large numbers of sheep and cattle on wastewater-irrigated pasture, and in fact it's the largest producer of livestock in the whole of the State of Victoria.</td></tr>
<tr><td>12.</td><td>
</td><td>Agriculture consumes on average around 70% of all water abstracted in the world, and this excludes rain-fed agriculture.</td></tr>
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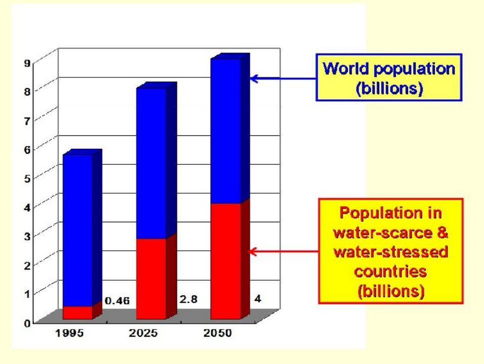
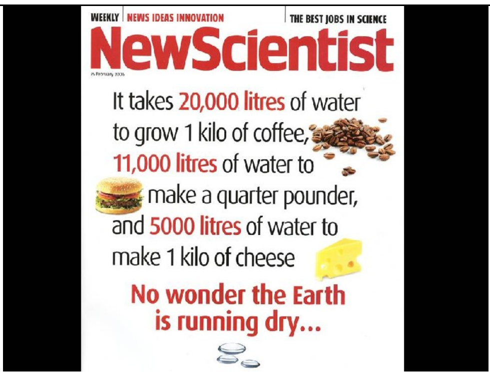
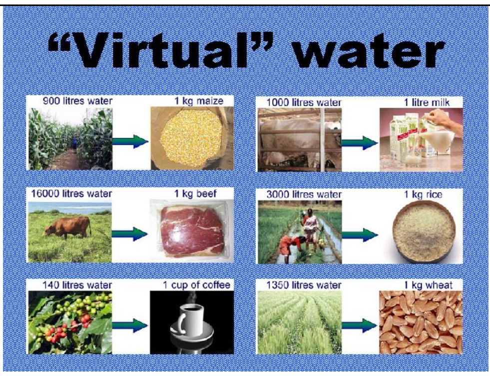
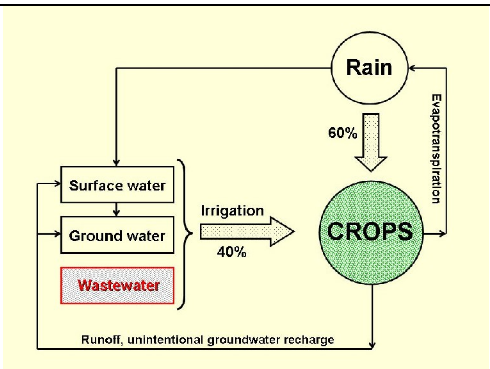
<tr><td>13.</td><td>
</td><td>But this will have to stop. We are living in a world of rapidly increasing water stress and water scarcity, so agriculture will have to be much less extravagant with the water it uses.</td></tr>
<tr><td>14.</td><td>
</td><td>And we will have to choose more carefully what foods we grow: fewer water-hungry crops and less water-intensive meat production.</td></tr>
<tr><td>15.</td><td>
</td><td>This slide says much the same as the last, but it terms the water used to produce meat and crops that are exported as 'virtual water', the water used to grow the food being exported.</td></tr>
<tr><td>16.</td><td>
</td><td>This is what agriculture does just now: 40% of crops are irrigated, mostly with surface and ground waters, and 60% are rain-fed. But, as the periurban population in developing countries increases, more water will be needed for cities and towns, so …</td></tr>
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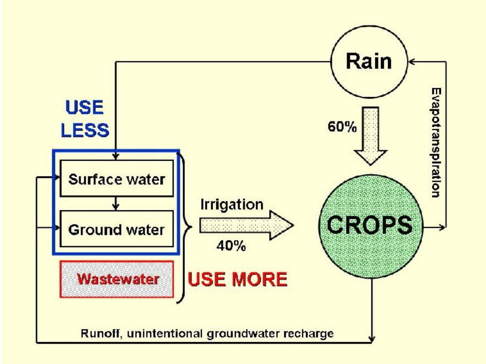
**17.**

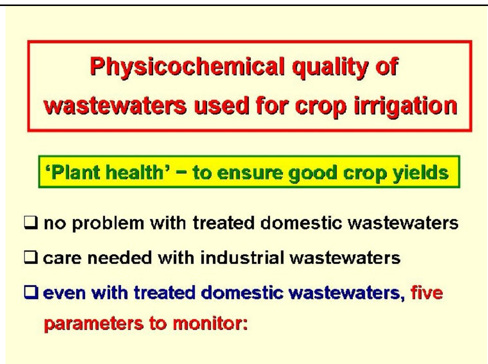



agriculture will have to use less freshwater and more treated wastewater.

**18.**


There are two basic aspects of wastewater use in agriculture that we must consider. Firstly, what can be termed 'crop health' and here it's the physicochemical quality of the wastewater that's important; and secondly, human health where it's the wastewater's microbiological quality that's important.

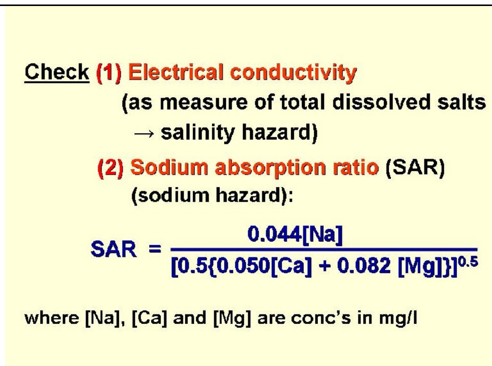
**19.**




So first 'plant health'. In general, there's little or no problem with treated domestic wastewaters, but we need to be more careful when there are large proportions of industrial effluents present in municipal wastewaters.

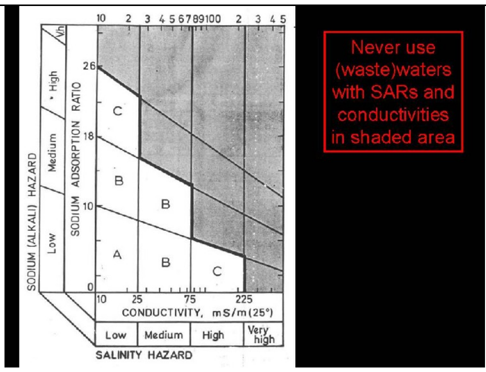
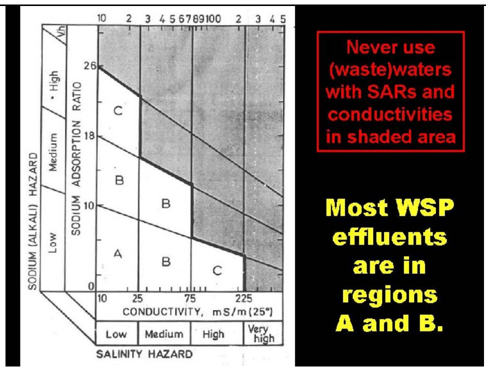
Even with treated domestic wastewaters there are five parameters that we need to monitor during the irrigation season.

**20.**




The first of these is **electrical conductivity**, used as a convenient measure of the total dissolved salts present. This is a measure of the 'salinity hazard': clearly we can't irrigate many crops with very saline water as they won't grow at all or the crop yield will be minimal.

The second parameter is the **sodium absorption ratio**, which is defined as the sodium concentration in meq/l divided by the square root of the mean of the calcium and magnesium concentrations, again both in meq/l. Actually in the equation on the slide the concentrations are in mg/l and the numbers 0.044, 0.050 and 0.082 just convert mg/l to meq/l for each of these

<table>
<tr><td></td><td></td><td>elements. SAR is important because if an irrigation water has too much sodium, then the sodium ions displace the calcium and magnesium atoms in the clay minerals that make up the soil, and the soil may become ‘sodium saturated’. This damages the soil structure and its internal drainage, so again crop yields are reduced.</td></tr>
<tr><td>21.</td><td>
</td><td>This chart was adapted from one produced by the US Department of Agriculture in the 1950s. It shows that really electrical conductivity and SAR have to be con-sidered together. We can grow anything in region A on the chart, most things in region B, but we have to be very careful with what we grow in region C, and we should avoid the shaded area altogether.</td></tr>
<tr><td>22.</td><td>
</td><td>Fortunately most waste stabilization pond effluents are in regions A and B of the chart.</td></tr>
<tr><td>23.</td><td>(3) Boron<br>– citrus fruit trees sensitive to 0.2 mg B/l, also deciduous nut trees<br>– most crops can tolerate 2 mg B/l<br><br>(4) Total nitrogen<br>– too much nitrogen can reduce crop yields (there may be a more luxuriant growth of non-useful parts of the crop)<br>– most crops can tolerate 30 mg N/l, but some only 5 mg N/l</td><td>The third parameter of importance is boron, and boron in wastewaters comes from perborates used in domestic detergents. Most crops can tolerate 2 mg B per litre, but citrus fruit trees and deciduous nut trees are very sensitive to boron levels and they can only tolerate 0.2 mg B/l.<br>The fourth parameter is total nitrogen. Nitrogen is, of course, a major plant nutrient; but too much total N may induce luxuriant growth of the non-useful parts of the plant − for example, maize plants may have beautiful green leaves but small cobs. Most plants can cope with total N concentrations up to ~30 mg/l, but some with only 5 mg/l.</td></tr>
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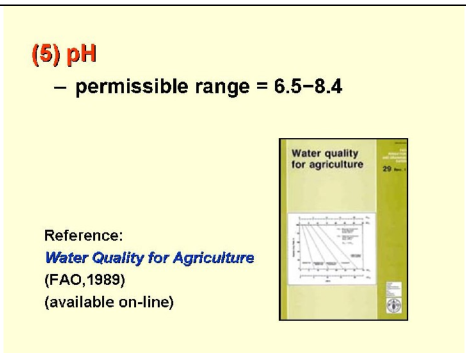
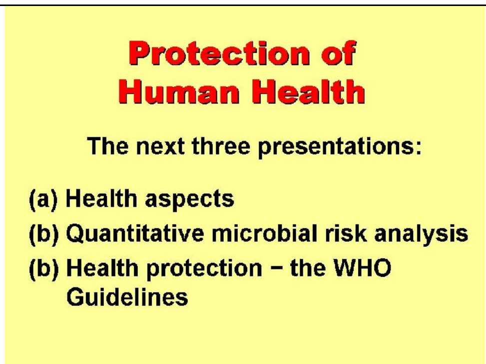
| **24.** |  | The final parameter to monitor is **pH**, and this should be in the range 6.5–8.4 (i.e., broadly neutral).<br><br>This publication from the Food and Agriculture Organization is extremely detailed, with full explanations of SAR, electrical conductivity and so on. It also lists the tolerance of various crops to boron, total nitrogen, heavy metals, etc. |
| **25.** |  | Crop health is important as we don't want to reduce crop yields when we irrigate them with wastewater. But we also have to protect human health, the health of those who work in wastewater-irrigated fields and those who consume wastewater-irrigated foods, and this is the subject of the next three presentations. |