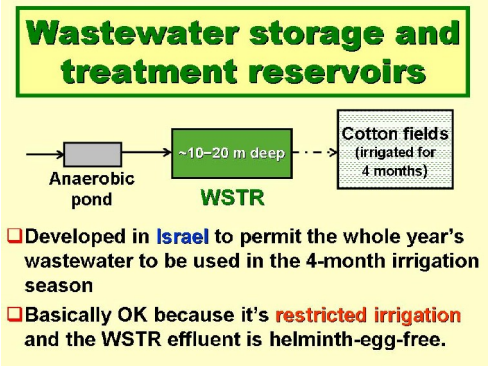
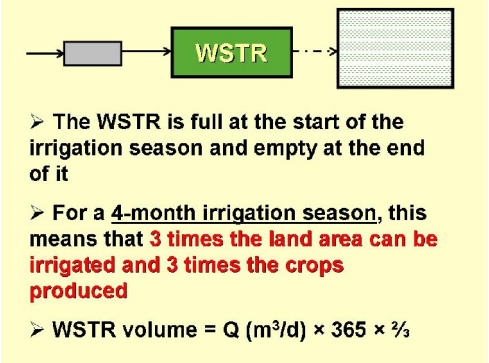
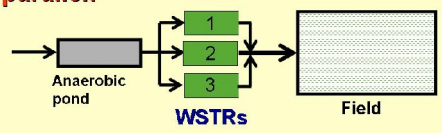
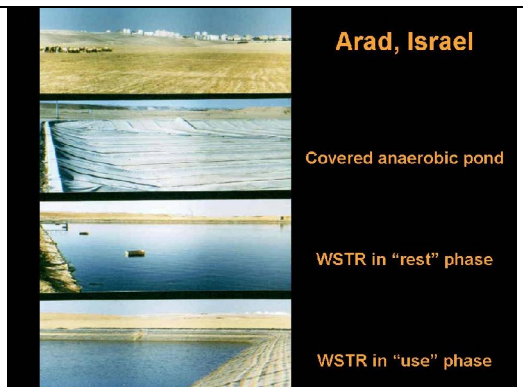
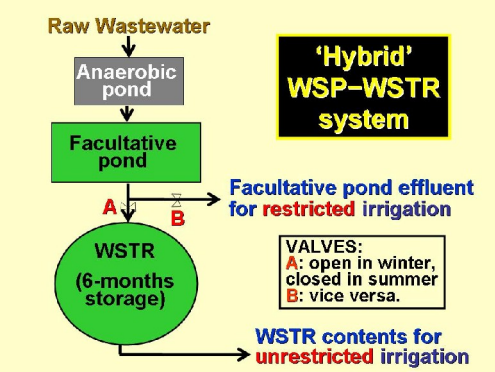
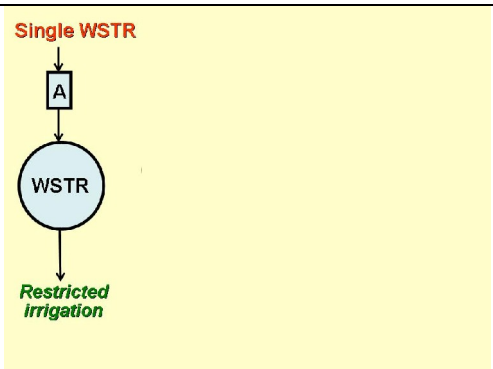
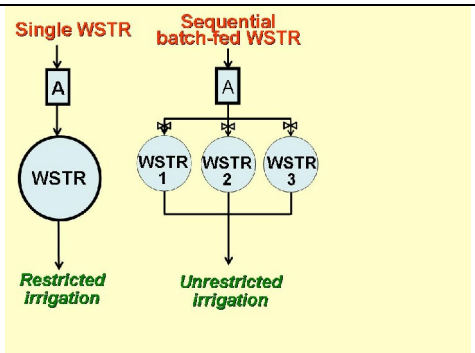
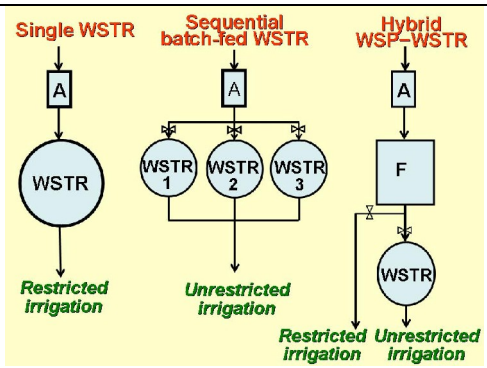
Wastewater Storage & Treatment Reservoirs (WSTR)

1.		This presentation is on **wastewater storage & treatment reservoirs**, which are an extremely advantageous technique to use when treated wastewater is to be used for crop irrigation, especially in arid and semi-arid areas.
2.		WSTR were developed in Israel to permit the whole year's wastewater to be used for irrigation, rather than just the wastewater produced during the irrigation season, which in Israel is ~4 months. The wastewater is treated first in an anaerobic pond and sometimes in a facultative pond as well. The reservoir is ~10–20 m deep and its contents are mostly used in Israel to irrigate cotton, and this is perfectly OK as this is **restricted irrigation** and what's pumped out of the reservoir is helminth-egg-free.
3.		The reservoir has to be full at the start of the irrigation season and it's empty at the end of the irrigation season. So, for a 4-month irrigation season, this means that 3 × the land area can be irrigated and therefore 3 × the amount of crops produced, so clearly it's a very advantageous system. For a 4-month irrigation season the reservoir has to hold a maximum of eight months' wastewater (that is, the wastewater produced in the non-irrigation season), so its volume is the wastewater flow in m^3/day × 365 × ⅔.

4.	**But what if the local farmers want to practise unrestricted irrigation?**	The single-WSTR system that we've been looking at is fine for restricted irrigation, but what can be done if the farmers want to practise **unrestricted irrigation**?
5.	**But what if the local farmers want to practise unrestricted irrigation?** **Use sequential batch-fed WSTRs in parallel:**  ➢Number of WSTR depends on length of the irrigation season – usually 3 or 4	Well, in this case we can use what are called '**sequential batch-fed WSTRs**', where we have an anaerobic pond then three (or sometimes four) WSTRs in parallel. The three (or four) reservoirs are operated in a special way so that during the irrigation season the contents of all the reservoirs are safe for unrestricted irrigation.
6.	**Operating cycle for each WSTR:** 1. Fill 2. REST 3. Use **For pathogen die-off:** minimum 2 months in summer, 4 months in winter (approx. – depends on temperature)	The operating cycle for each reservoir is: fill, rest and use. So if there are three reservoirs, at any one time one is being filled, one is resting and one is being used if, of course, it's the irrigation season. If it's not the irrigation season, then one's being filled and two are resting. The rest part of the cycle is very important as it's during this period that pathogen die-off occurs. And it's quite straightforward to arrange the operational schedule for each reservoir such that the one resting in winter or the cool season has a much longer rest period than the one resting in summer; say, 4 months rest in winter and 2 months rest in summer.
7.		This is the town of Arad in the north of the Negev Desert in Israel. The top photo in the slide shows the town on the horizon, with the desert in the foreground. The town's wastewater is treated in three sequential batch-fed WSTRs in parallel. First, though, treatment is in anaerobic ponds, one of which is covered (as shown in the second photo) to demonstrate that biogas recovery was feasible; next there are facultative ponds, although these aren't strictly necessary; and then we have the three sequential batch-fed WSTRs, and the two lower photos show one of these in the rest phase and another in the use phase.

8.		Finally, we can have a 'hybrid' system, a **hybrid pond-reservoir system**. This produces treated wastewater for both restricted and unrestricted irrigation. The wastewater is treated first in an anaerobic and a facultative pond, and then in the non-irrigation season the facultative pond effluent fills a single WSTR. Immediately before the irrigation season starts the reservoir is full, just like the single-WSTR system we considered at the beginning of this presentation. During the irrigation season the reservoir contents are used for unrestricted irrigation and the facultative pond effluent is used for restricted irrigation.
9.		So, in summary, we can have three types of WSTR system. First there's the **single-WSTR system for restricted irrigation**, …
10.		and then there's the **sequential batch-fed WSTR system for unrestricted irrigation**, and …
11.		finally there's the **hybrid system for both restricted and unrestricted irrigation**.

12.	**Wastewater is simply too valuable to waste**	These wastewater storage & treatment reservoir systems are really useful in areas where irrigated agriculture is limited by the amount of irrigation water available. By using WSTR systems we can increase the quantity of water, in this case treated wastewater, that can be used for irrigation, so more food crops and other crops can be produced. WSTR systems don't waste wastewater and this is very important in water-short areas.