Fundamental Elements of Agricultural Water Use Efficiency

by

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Let's talk about "efficiency"

1. We'll start with what we might know:

What's a typical gasoline engine efficiency?

So what is “efficiency”??

1. We’ll start with what we might know:

What’s a typical gasoline engine efficiency?

Does everyone here drive a hybrid? – I’m serious!

So what is “efficiency”??

2. Let’s move on to Irrigation Efficiency:

What’s a typical “Irrigation Efficiency”?

What specific equation did you use for Irrigation Efficiency?

It is a number, and it is computed using an equation.

What specific equation did you use for Irrigation Efficiency?

$$IE = \frac{\text{Irrigation Water Beneficially Used}}{\text{Irrigation Water Applied} - \Delta\text{Storage}} \times 100$$

Burt, C.M., A.J. Clemmens, K. Solomon, T.A. Howell and T.S. Strelkoff. 1999. Irrigation Performance Measures: Efficiency and Uniformity. Closure. Journal of Irrigation and Drainage Engineering. ASCE 125(2):98-100.

Were you thinking about…

…Field Irrigation Efficiency?

…Farm Irrigation Efficiency?

…Irrigation District IE?

…Basin (e.g., Sacramento Valley)?

Burt, C.M., A.J. Clemmens, K. Solomon, T.A. Howell and T.S. Strelkoff. 1999. Irrigation Performance Measures: Efficiency and Uniformity. Closure. Journal of Irrigation and Drainage Engineering. ASCE 125(2):98-100.

But back to gasoline vs. water

- If you waste gasoline, it's gone!

- If you have an inefficient irrigation, most of that "wasted water" isn't gone. It just went somewhere else.

TOTALLY DIFFERENT CONCEPTS !!!

SAME WORDS

So – you must be VERY skeptical when water experts talk about making more water available for California by going to drip!

****THERE ARE MANY REASONS THAT FARMERS HAVE CONVERTED TO DRIP****

I am a big advocate of drip/micro on many crops.

I have trained an extensive network of irrigation dealers in California how to properly design drip systems.

INCORRECT assumption:

Reduce ET via drip/micro.

Think about it:

- Plants have less stress (more Transpiration)
- A portion of the bare ground surface is wet a high percentage of time

  (more Evaporation)

Are there exceptions?

- Of course there are always exceptions.

Probably the biggest one is the use of drip (as opposed to overhead sprinklers) on wine grapes on the Central Coast. Those wine grapes are pruned to have a small canopy area, and are irrigated infrequently. Water in the middle of the drive rows (as applied with sprinklers) would be non-beneficial evaporation.

Details of Efficiency:

Is it true that:

Irrigation Efficiencies for Projects and Basins

are higher than:

Irrigation Efficiencies for Individual Fields?

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Irrigation Efficiencies for Projects and Basins

are higher than:

Irrigation Efficiencies for Individual Fields?

LET'S COMPARE

Madera Irrigation District (SJ Valley)

vs.

Imperial Irrigation District

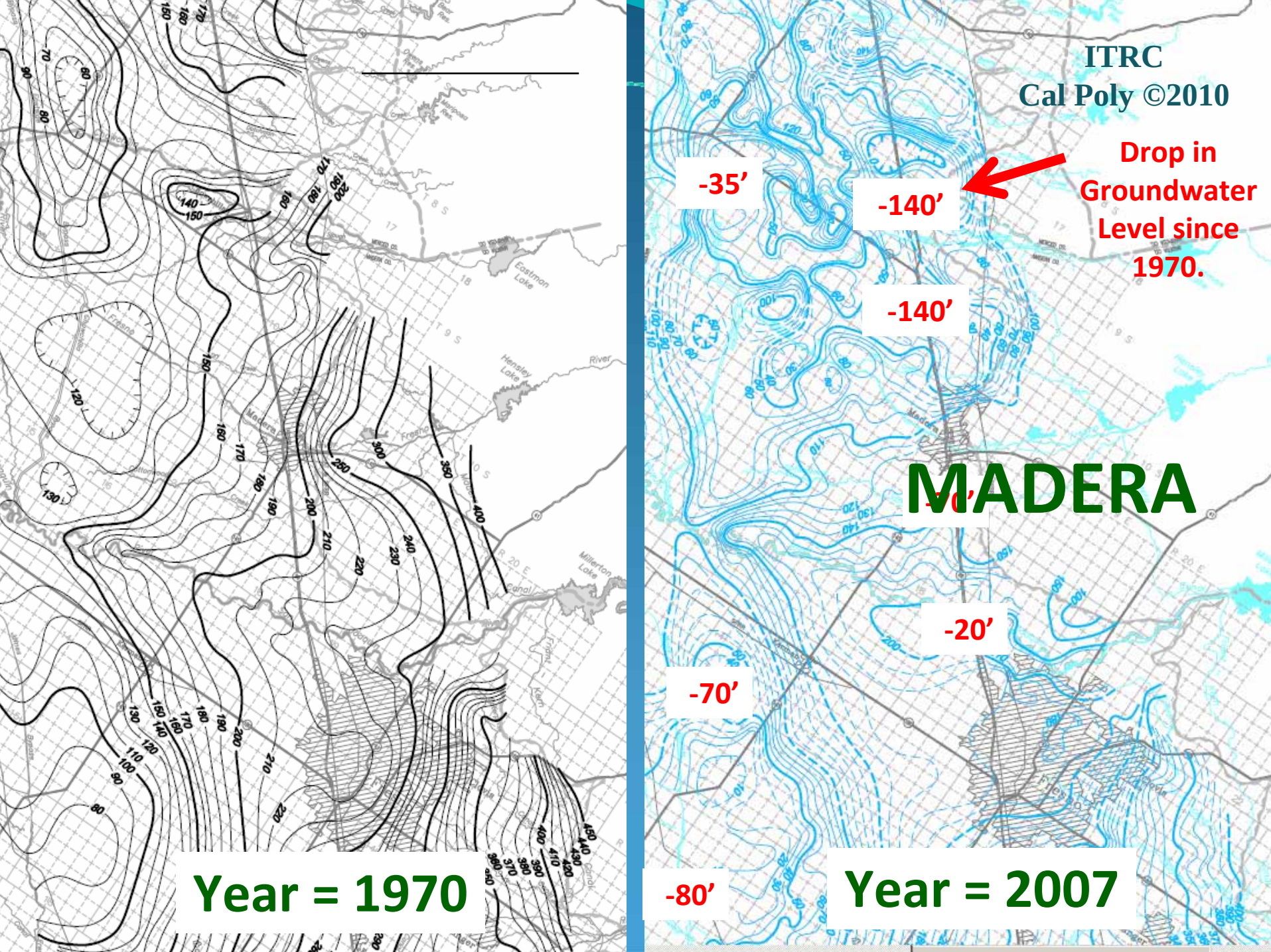
ITRC

Madera Irrigation District

Classic eastern San Joaquin Valley

- Most farmers have dual supplies
    * Wells
    * Irrigation District
- Over-irrigation during dry years recharges the groundwater

District Efficiency > Field Efficiency


ITRC
Cal Poly ©2010
Drop in Groundwater Level since 1970.
-35’
-140’
-140’
-70’
-20’
-80’
MADERA
Year = 1970
Year = 2007

Conclusion:

- Improving on-farm irrigation efficiency in Madera Irrigation District isn't going to make more water available for other uses.
- Surface water isn't flowing out of MID.
- The groundwater level is dropping.

There is more irrigated acreage than can be supported right now. It's not an Irrigation Efficiency problem.

1976 – Westside Farmers moved to groundwater areas NE of Madera.

And this expansion continues today.

By the way:

It's easy to get confused. People with various agendas will shift the argument and confuse things.

The matter I am addressing is this:

Conservable Water and Irrigation Efficiency.

Shifting the argument

It is true that improved on-farm water management can result in:

1. Improved crop yields and quality
2. Reduced application of fertilizers
3. Reduced groundwater contamination
4. Less energy consumption
5. Other improvements

But, those benefits are

NOT THE SAME

as

True Water Conservation

Another point:

The further you are from the fields, the easier it is to have perfect irrigations, make a profit, predict weather, grow great crops, etc.

There are limits to:

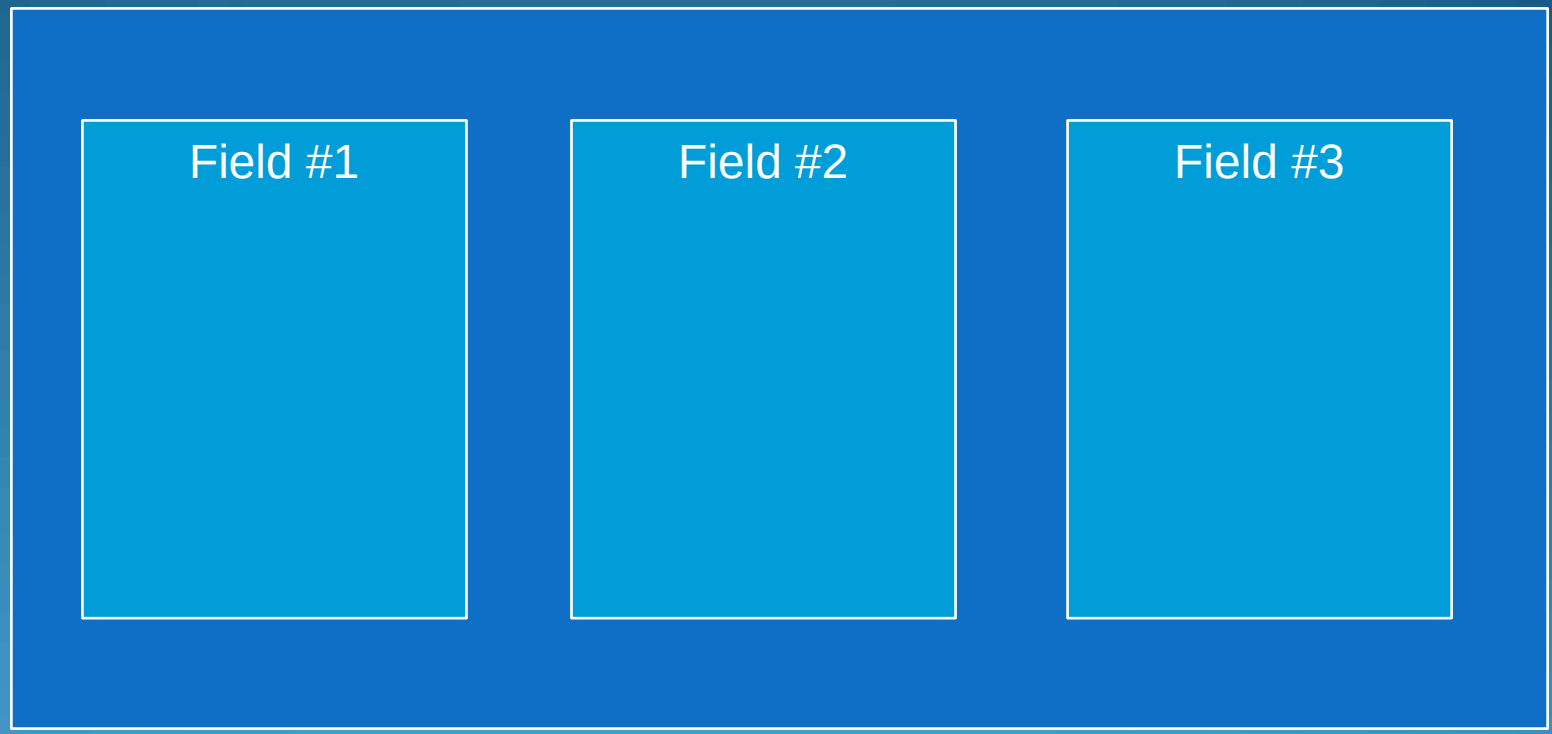
- How good we can get
- $$ available
- Profit with crops

Madera Irrigation District

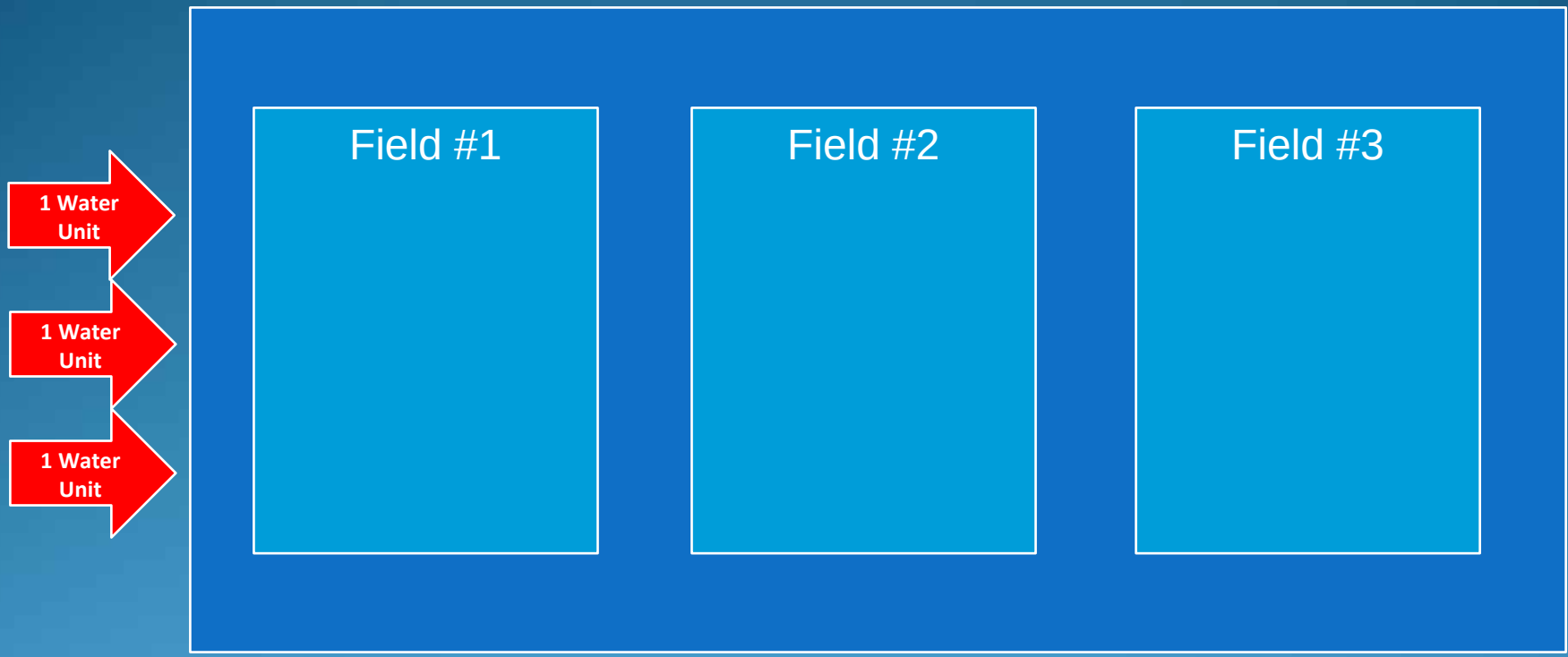
(revisited)

Madera Irrigation District

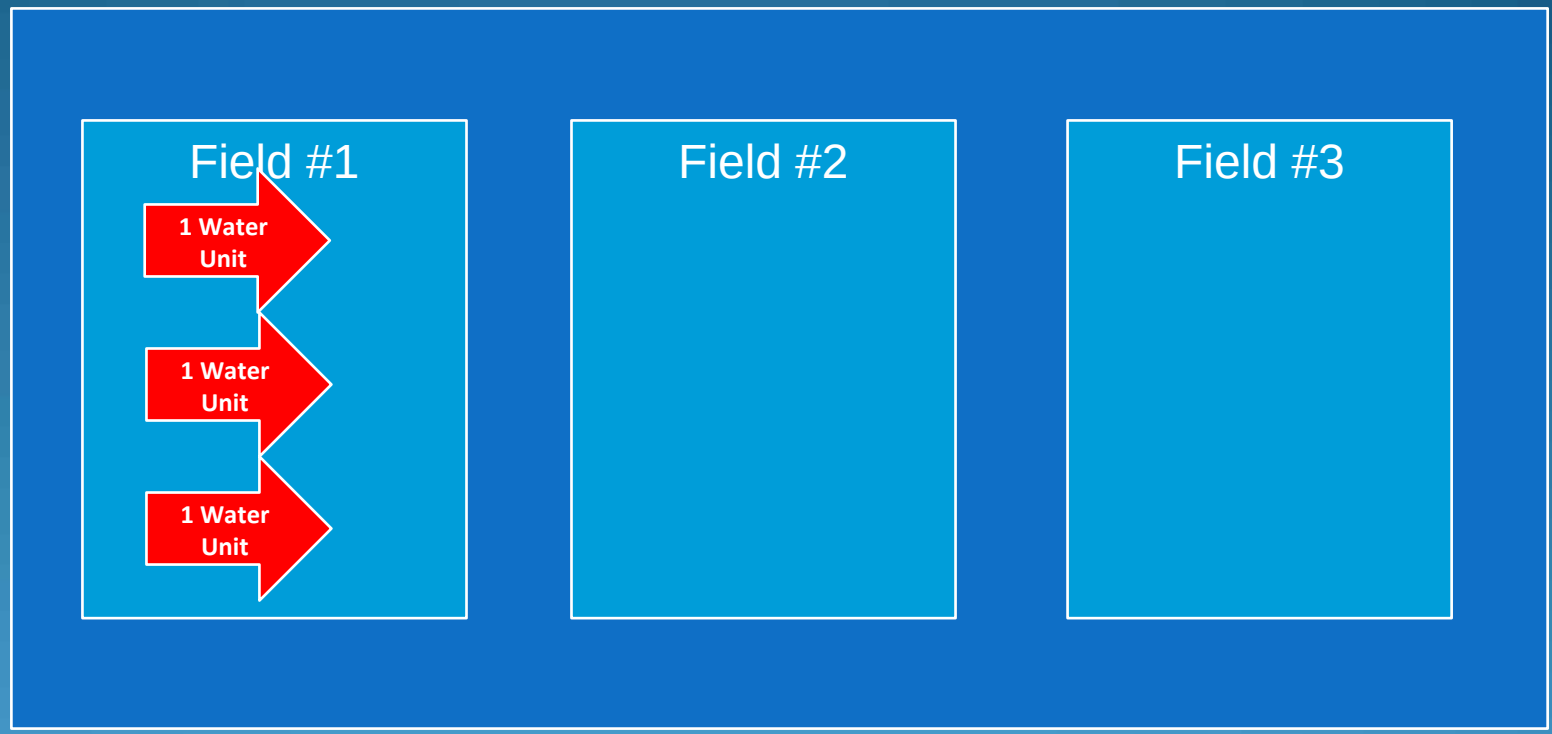
Assume there is a basin with three fields



There are three units of water that enter the basin boundaries



All three units of water are provided to Field 1



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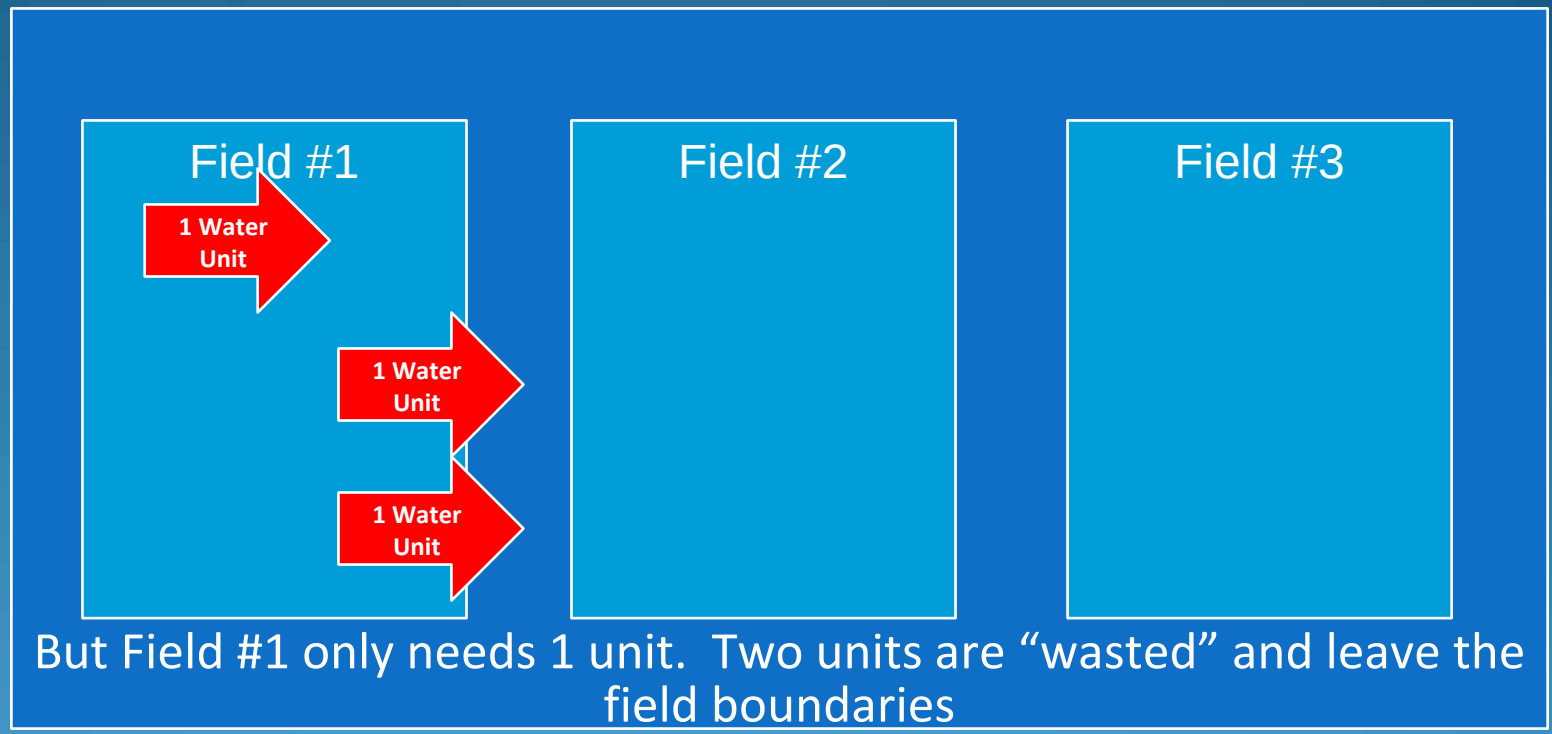

But Field #1 only needs 1 unit. Two units are "wasted" and leave the field boundaries

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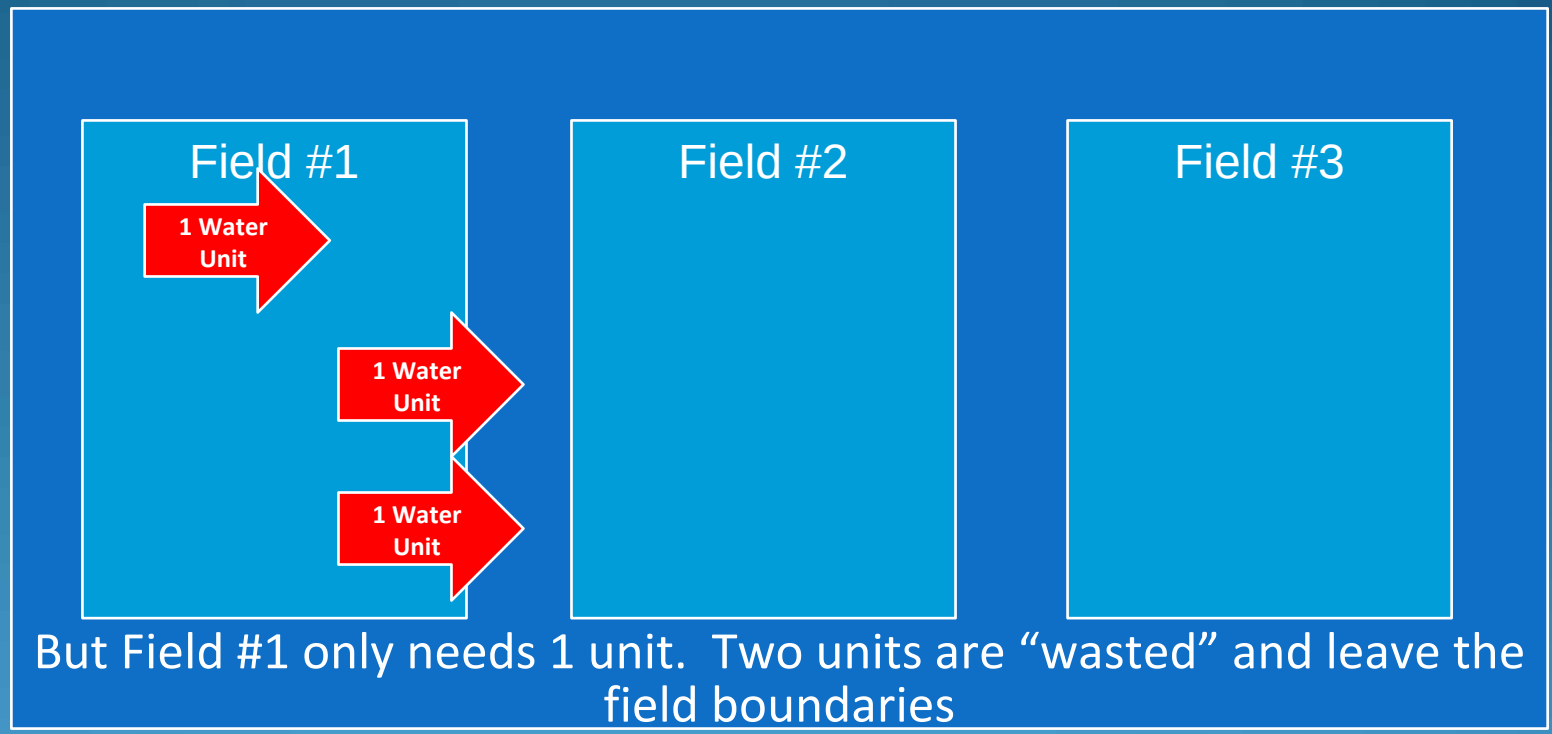


But Field #1 only needs 1 unit. Two units are "wasted" and leave the field boundaries

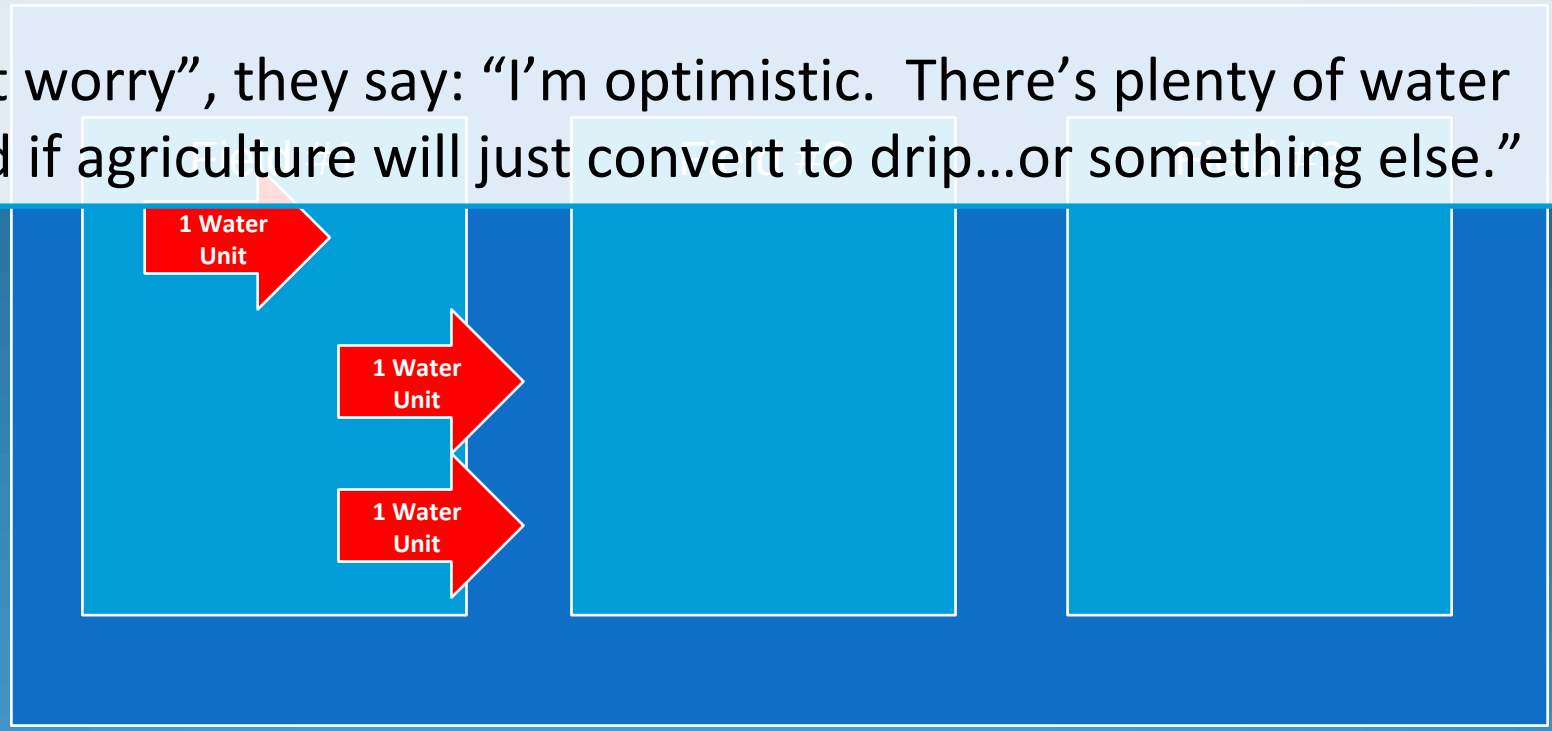
This would be called an

"on-farm irrigation efficiency of 33%". That is,

only 33% of the irrigation water was beneficially used (not accounting for salt balance).

It is common to hear claims, see videos, etc that say there is plenty of water available for agriculture …if only on-farm irrigation efficiency (such as this miserable 33%) would be improved.

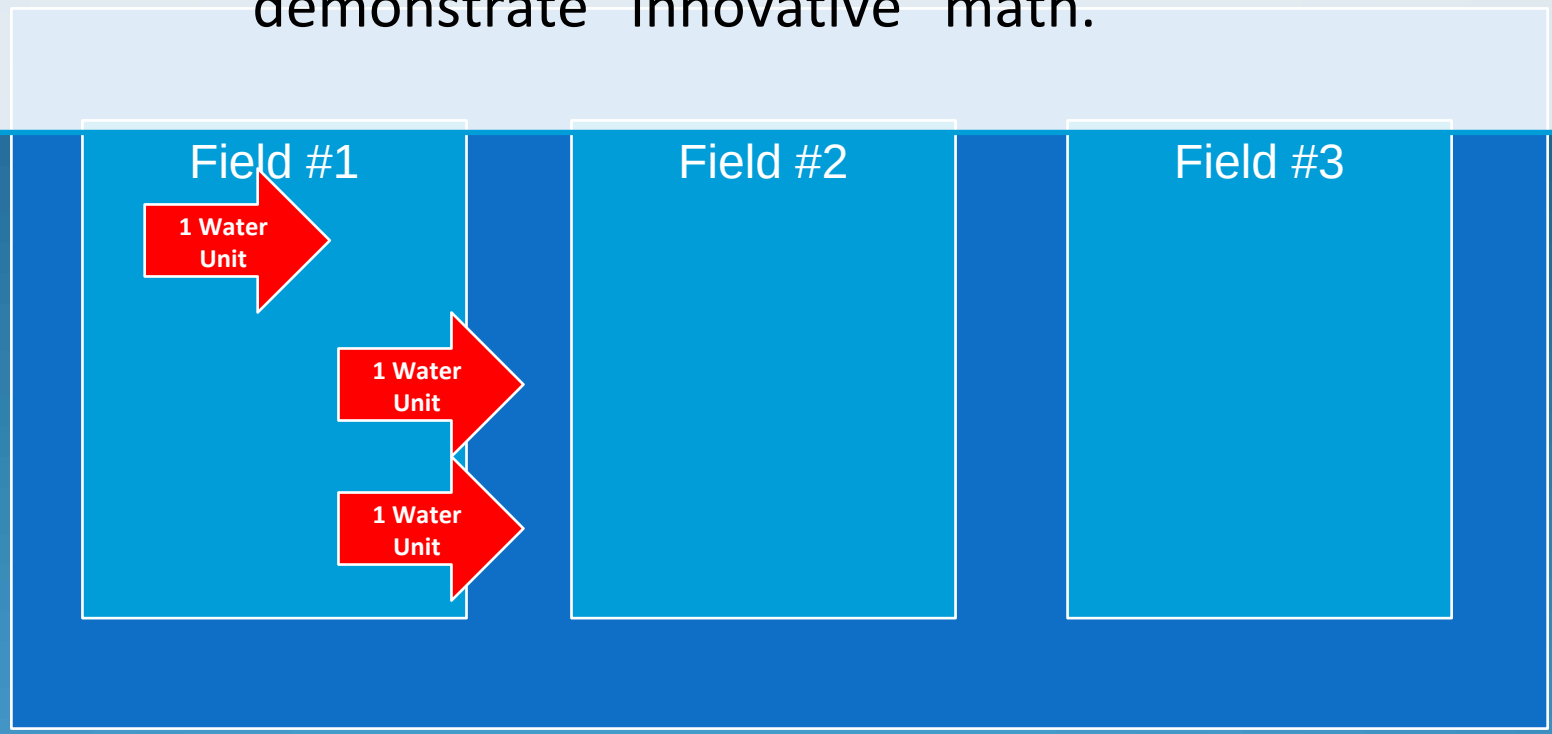
"Don't worry", they say: "I'm optimistic. There's plenty of water around if agriculture will just convert to drip…or something else."



This would be called an

"on-farm irrigation efficiency of 33%". That is, only 33% of the irrigation water was beneficially used (not accounting for salt balance).

Keep in mind that this 33% is extreme and I haven't seen it in California except for a few very strange cases. But it serves to demonstrate "innovative" math.



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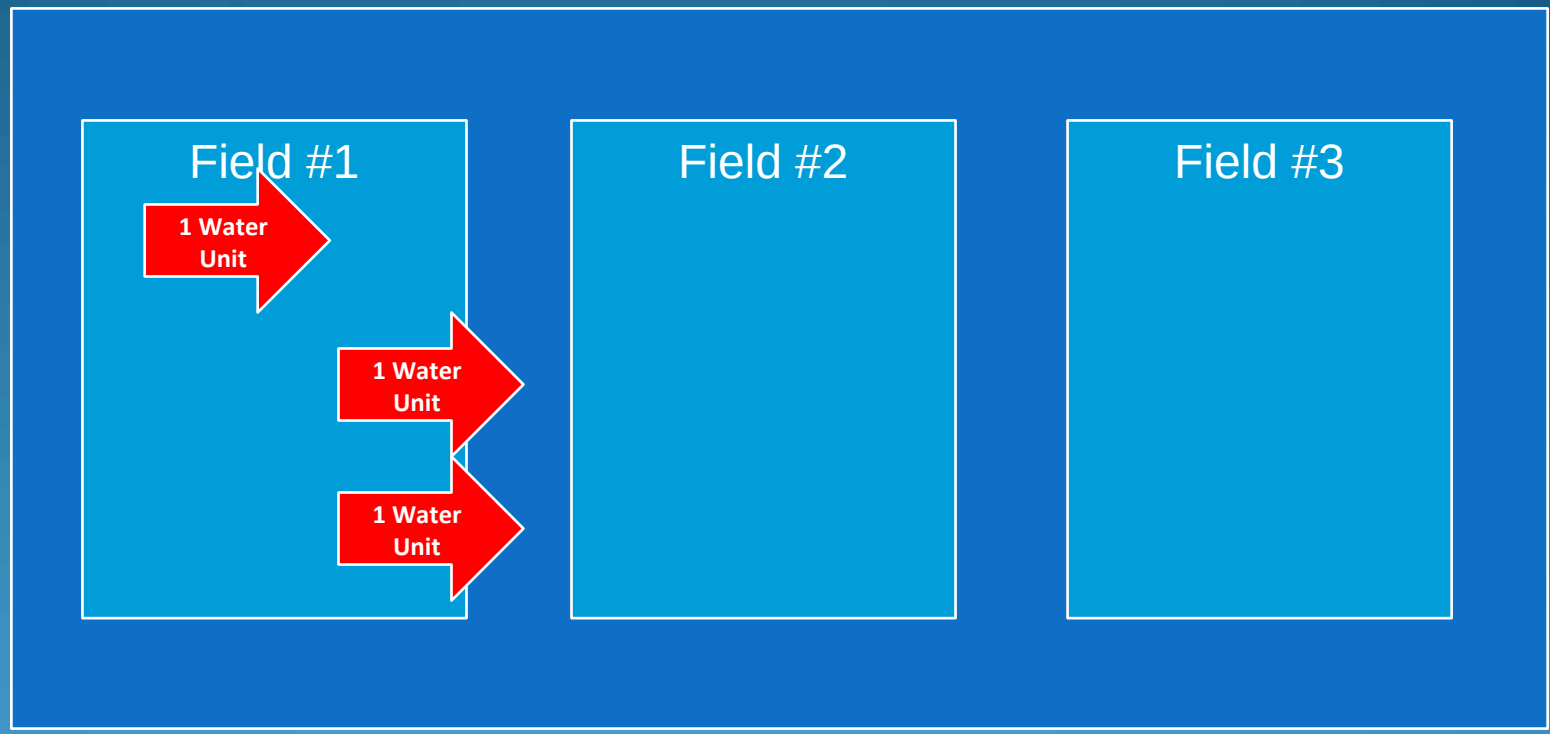
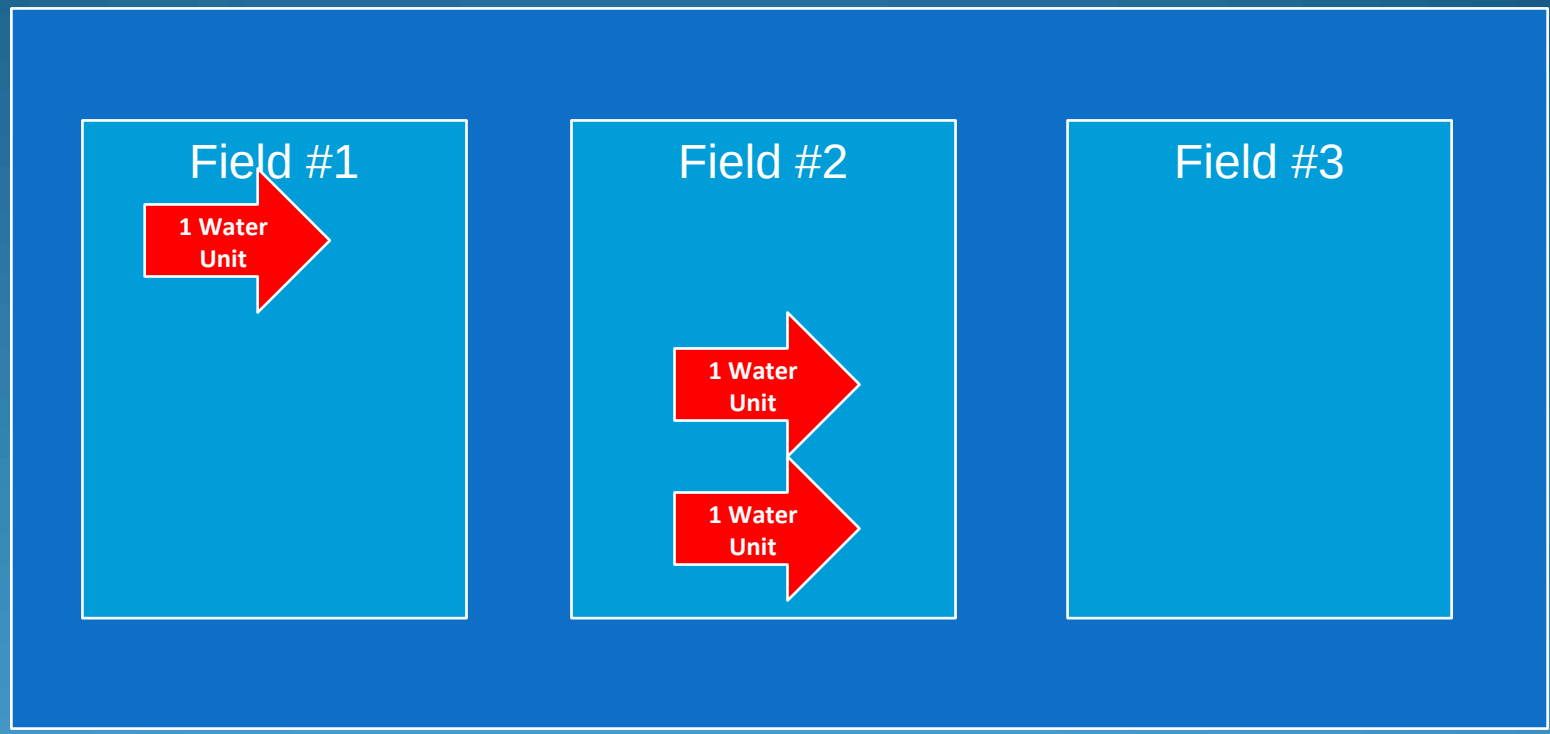
Back to the example. Field #1 has a 33% irrigation efficiency.



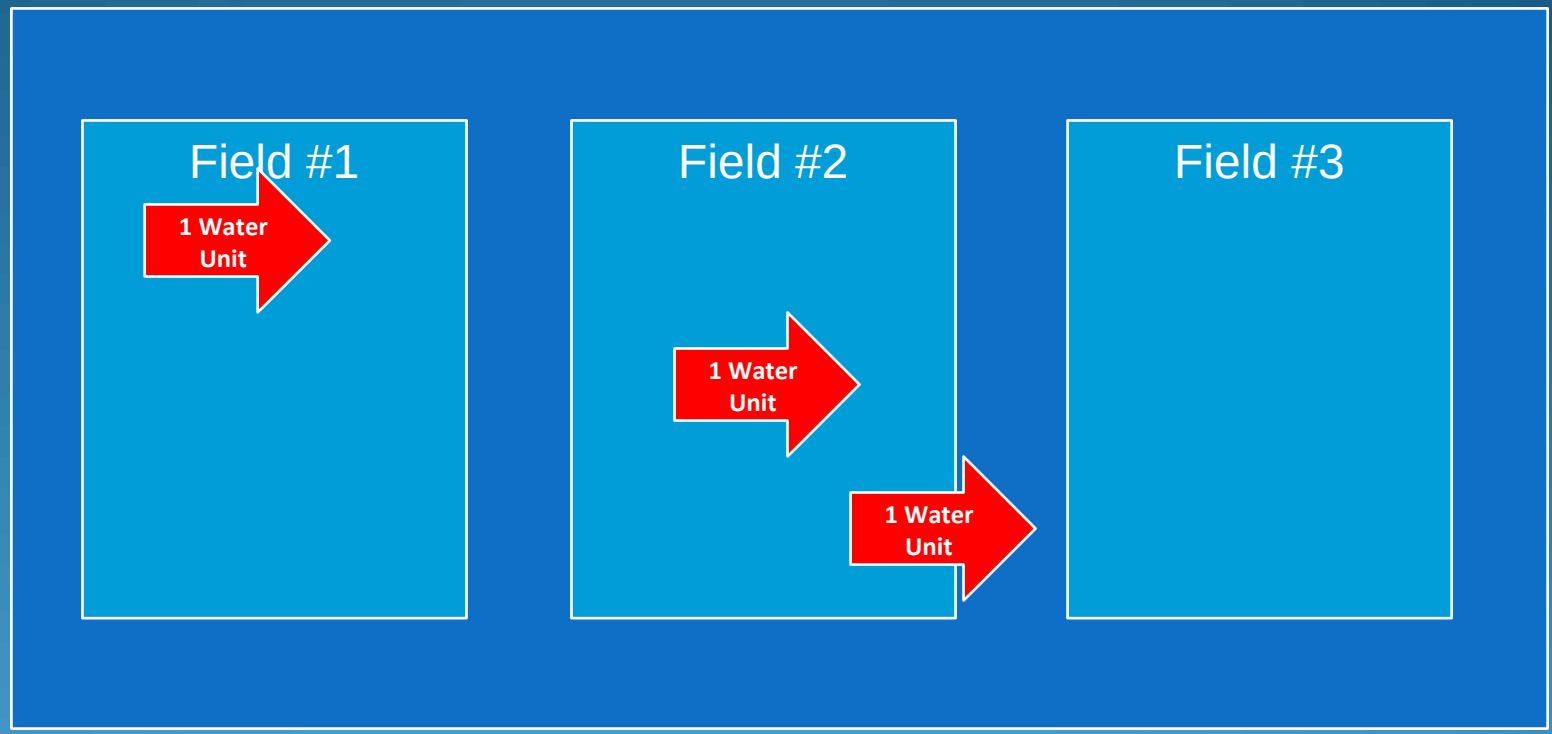
But in this example – as in most of the San Joaquin Valley and Sacramento Valley – the other two units don't just disappear.

Assume now that Field #2 receives the 2 remaining units.



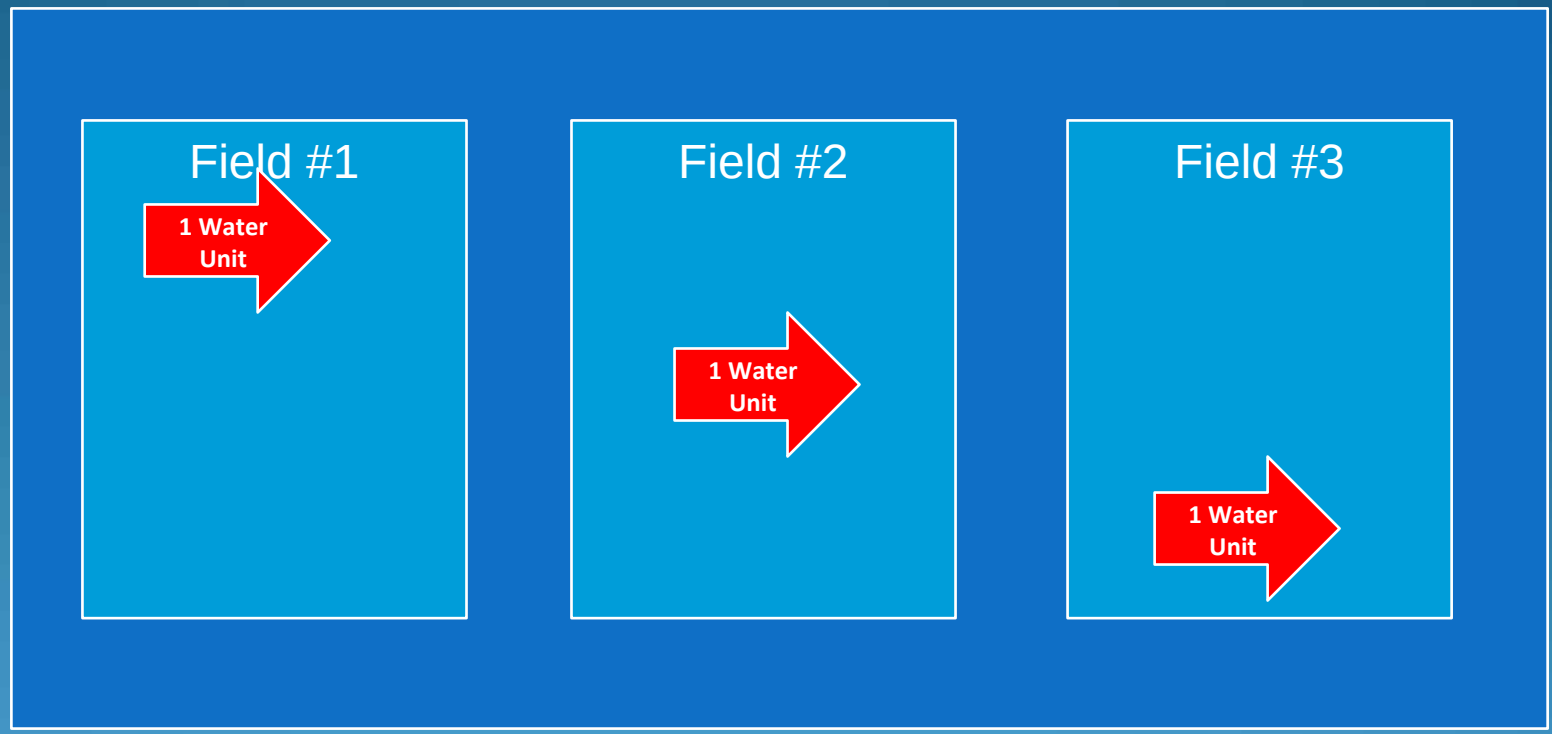
On a basin level, unless the water leaves the basin or goes to a salt sink, The water is still available for future use.

Assume now that Field #2 receives the 2 remaining units. But as with Field #1, it only needs 1 unit.



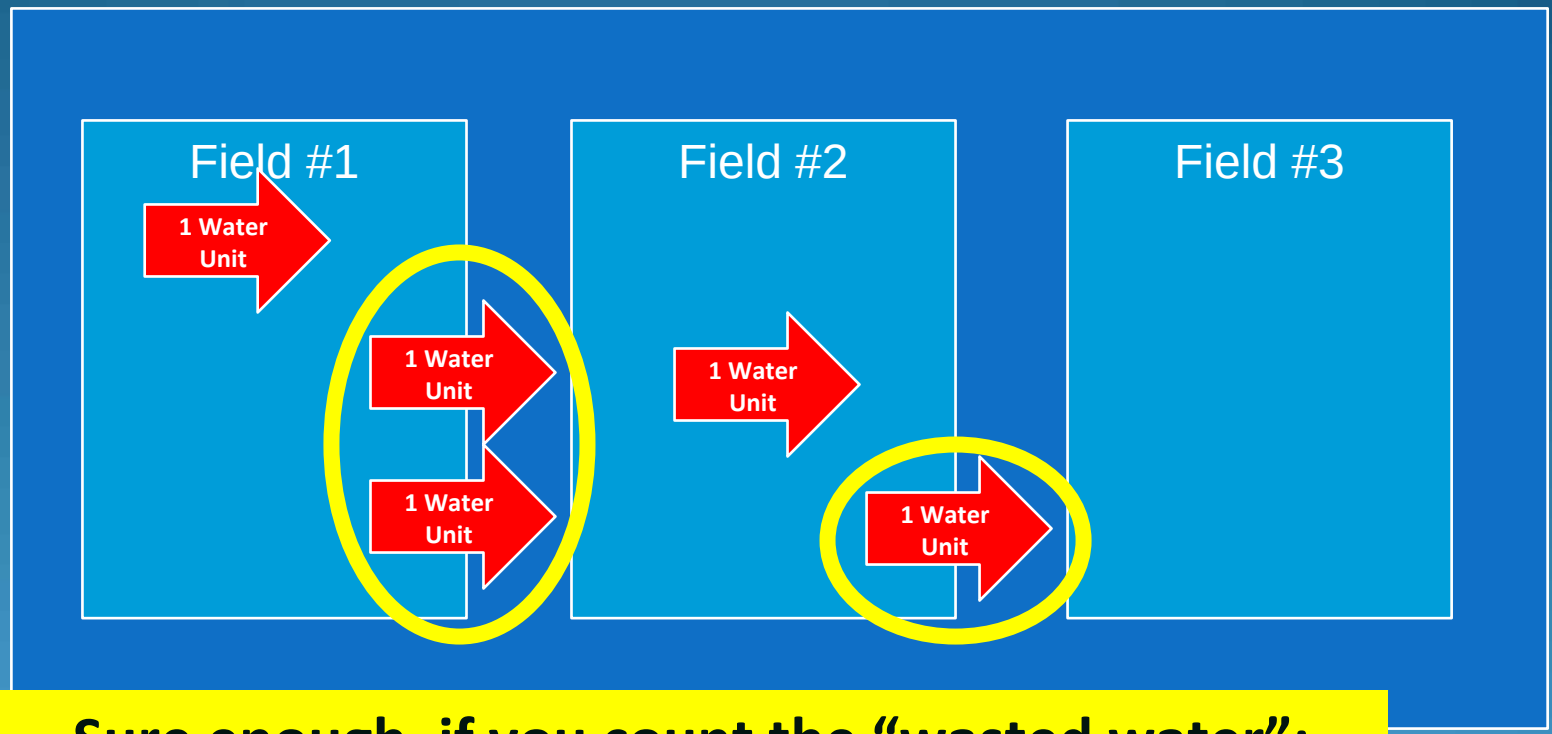
The irrigation efficiency of Field #2 is 50%. It only put 50% of the irrigation water to beneficial use.

Assume now that Field #3 receives the 1 remaining unit.
As with Fields #1 and #2, it only needs 1 unit.



The irrigation efficiency of Field #3 is 100%. It put 100% of the irrigation water to beneficial use.

Now here's how the math works…

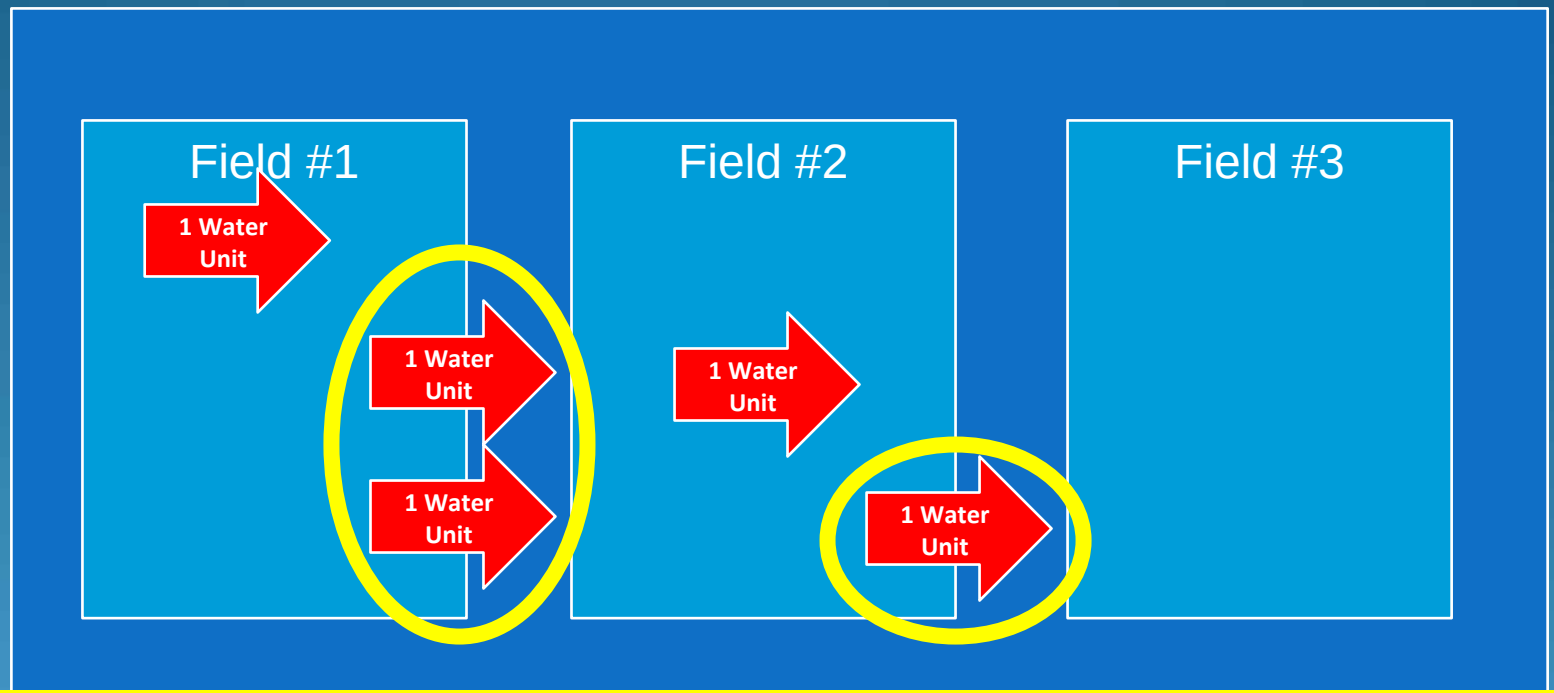


Sure enough, if you count the "wasted water":

2 units from Field #1
+ 1 unit from Field #2

= 3 total units of water

Now here's how the math works…



No one can deny this math: 2 + 1 = 3

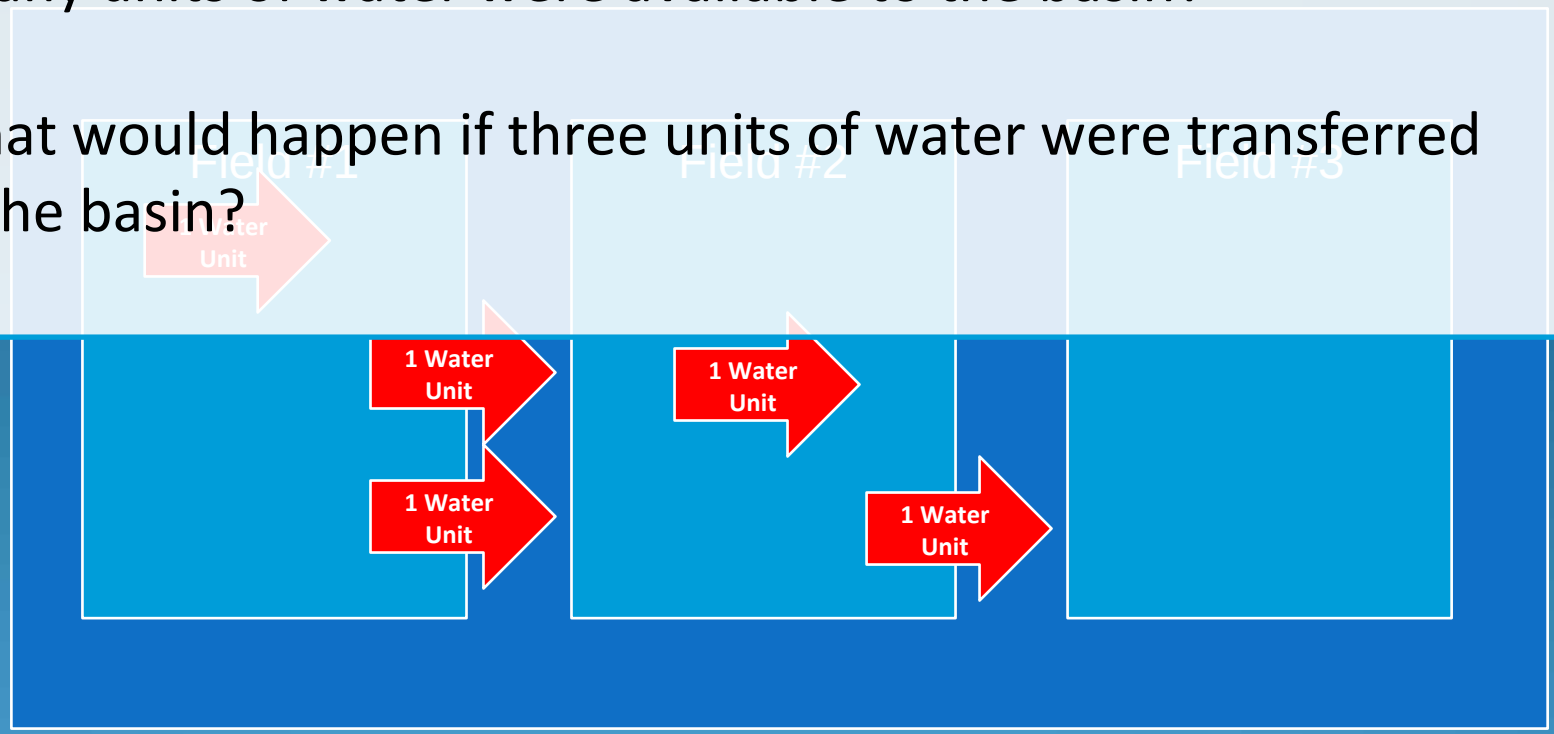
Here's the problem: The big jump is made to say:

"Therefore, agriculture can save 3 units of water. That water could be used for water transfers, for example. Or to remove the groundwater overdraft."

But wait!!!

How many units of water were available to the basin?

And what would happen if three units of water were transferred out of the basin?



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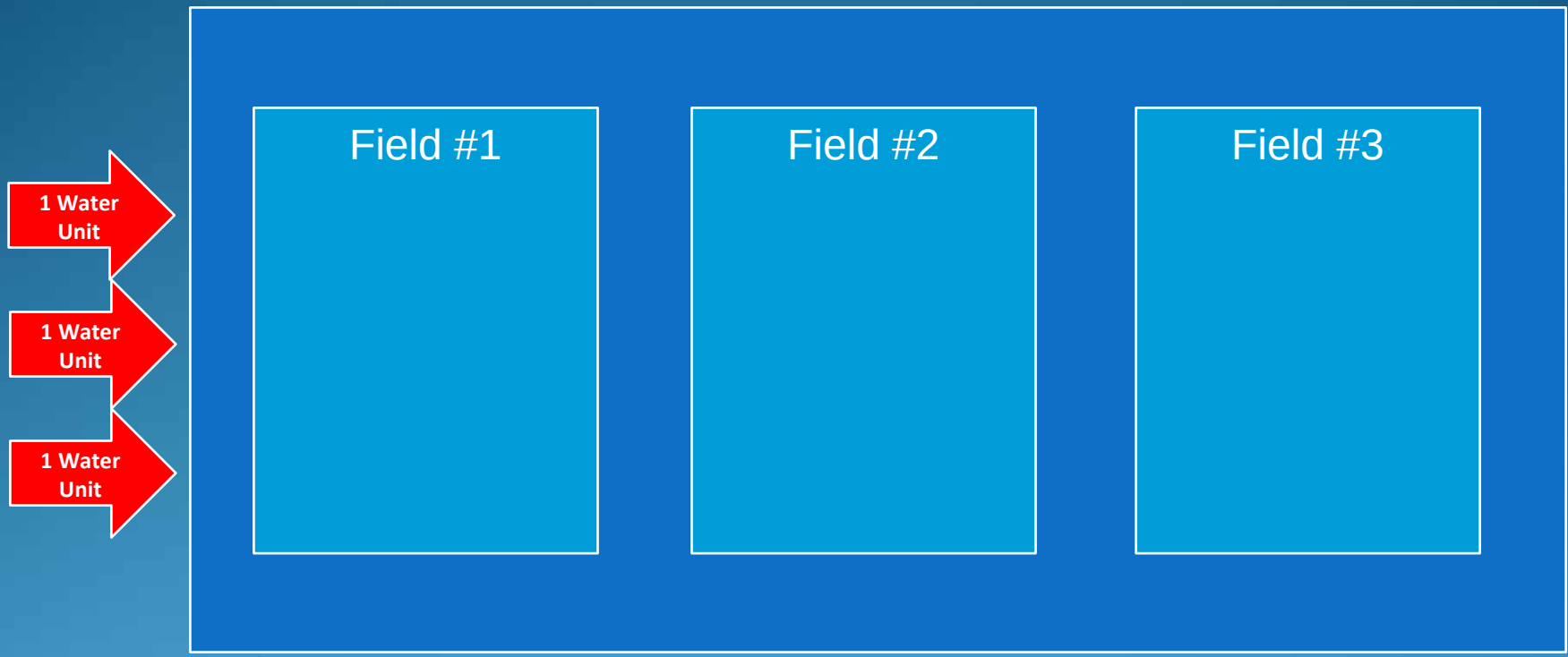
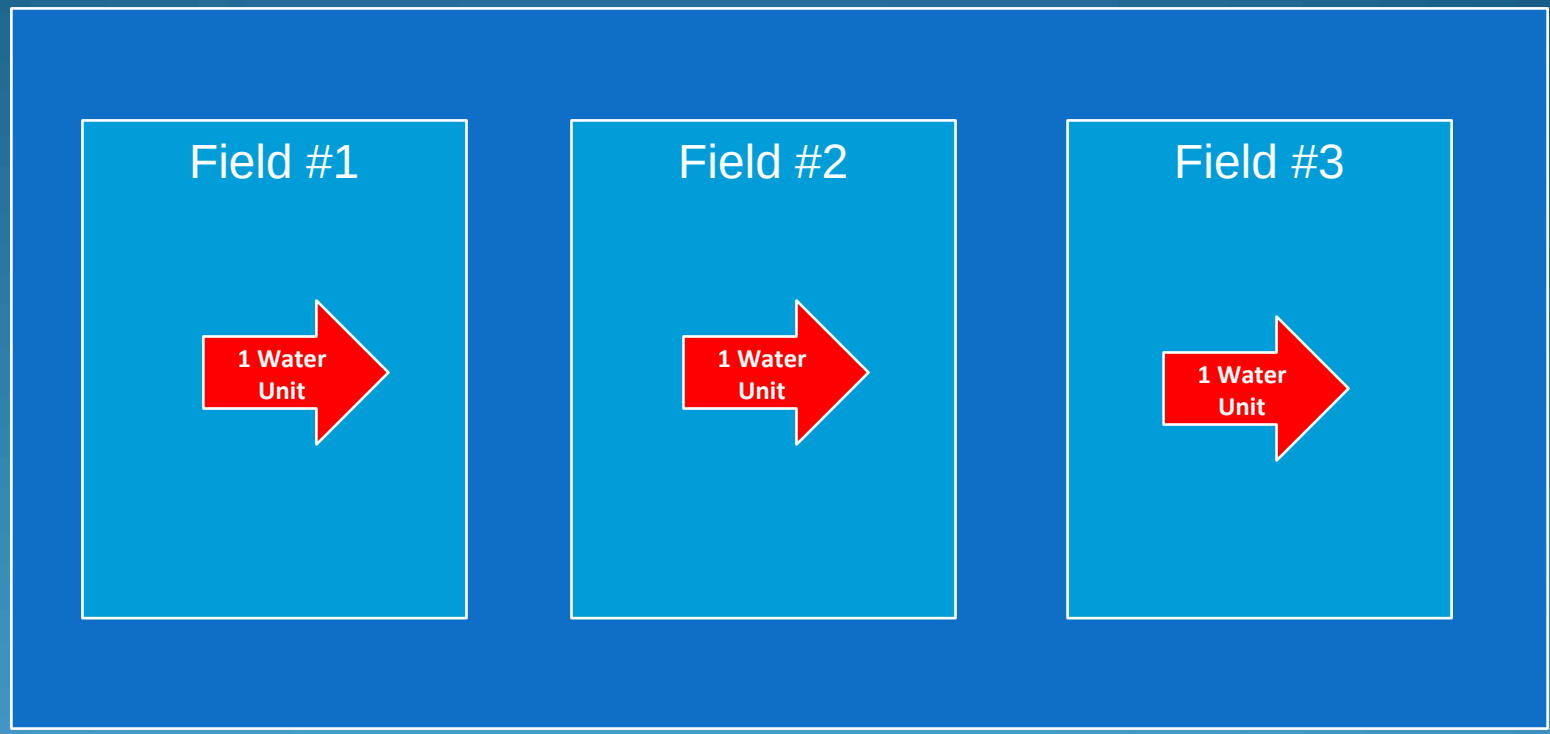


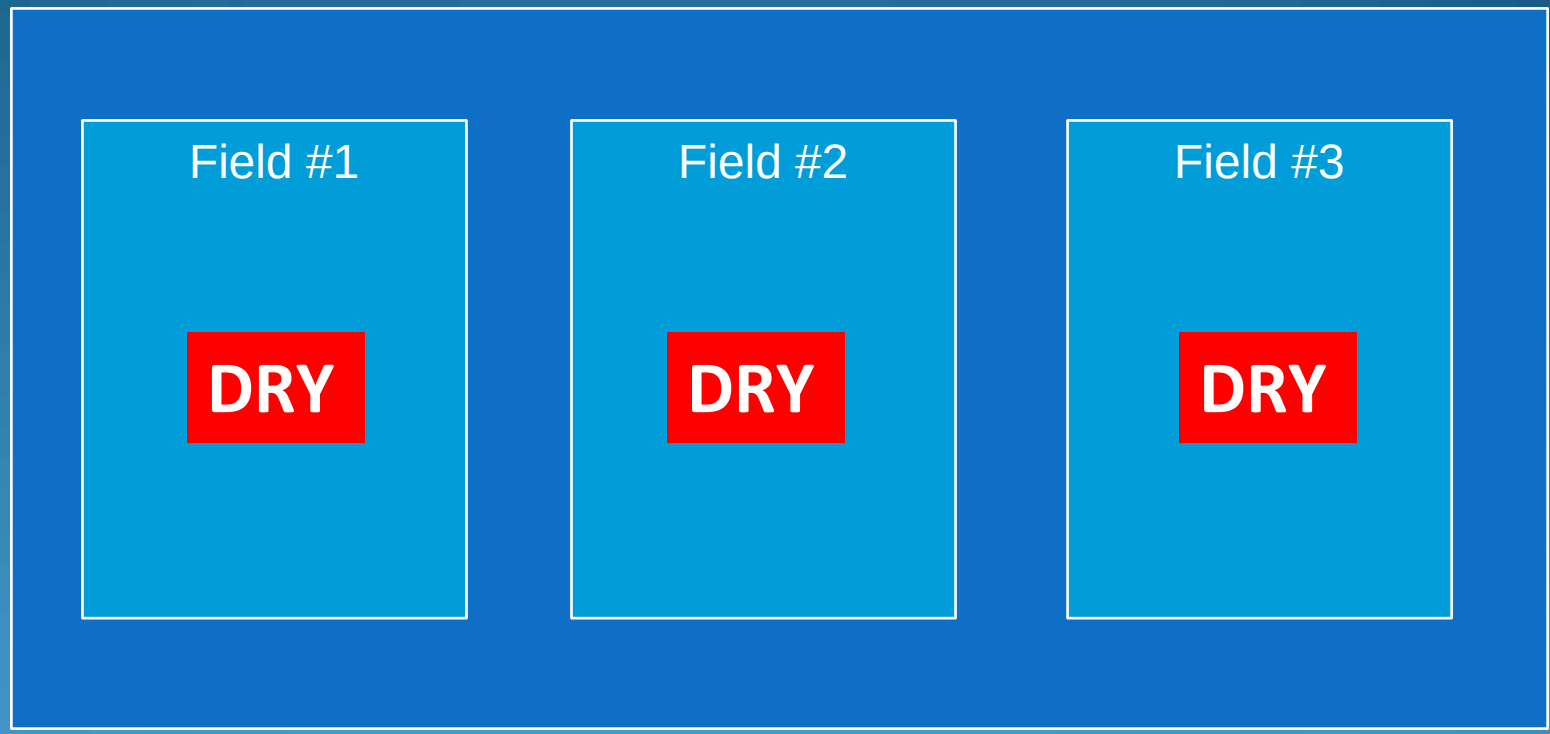
There are three units of water that enter the basin boundaries

Nothing leaves the basin boundary as "waste"



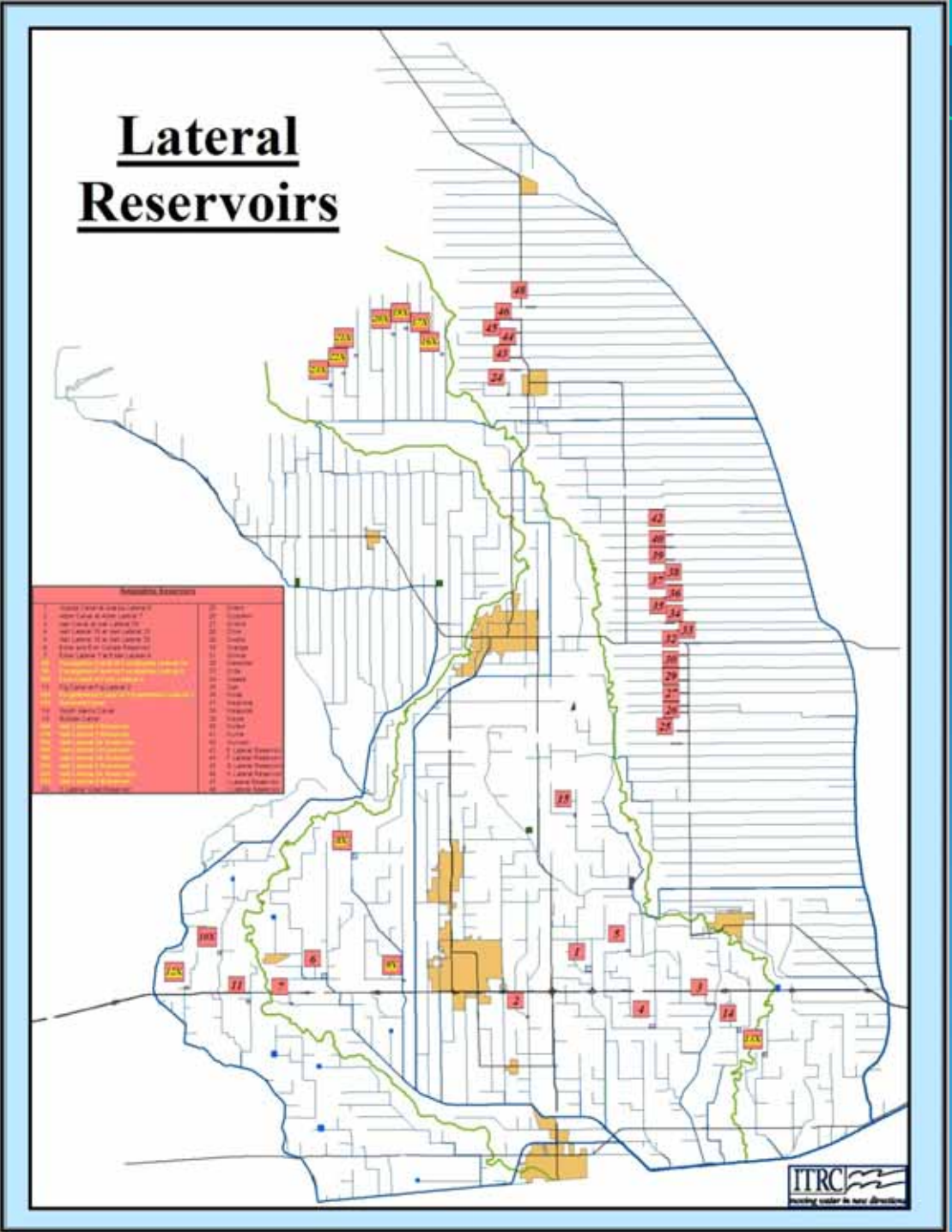
The BASIN irrigation efficiency is 100%

If three fewer units were available for the basin…



Here's the simple math: 3-3=0

How about Imperial Irrigation District?



Mid-Lateral Reservoirs

- 48 Identified
- 35 Selected
- 13 Future Options

THIS IS PART OF IID's WATER CONSERVATION EFFORT.

IS IID BLIND?
WASTING MONEY?

IID is completely different

- There is almost no recirculation of
  - Canal spills
  - Canal seepage
  - On-farm tailwater runoff
  - Deep percolation

District Efficiency < On-Farm Efficiency

IID is completely different

- There is almost no recirculation of
  - Canal spills
  - Canal seepage
  - On-farm tailwater runoff
  - Deep percolation

So if IID reduces canal spills, it <u>does</u> indeed conserve water.

Basics

There are only a few water destinations in a **basin**:

- Change in groundwater storage
- Surface or subsurface outflows
- Into the air (ET)
- Harvested crop (very minor)

Possibilities for all the wasted water in the San Joaquin Valley:

- It's hiding in the ground
- It's running down the San Joaquin River
- It's sneaking underground to LA or to the ocean
- There is excessive Evapotranspiration

How about RDI ? (Regulated Deficit Irrigation)

This is already STANDARD practice on

- Wine grapes (sugar %)
- Processing tomatoes (% solids)
- Cotton (maintain boll/vegetative balance)
- Almonds (to avoid hull rot)
- Pistachios (just look at the available water supply where pistachios are grown – there usually isn't enough to over-irrigate)

The point: The potential isn't as great as perceived

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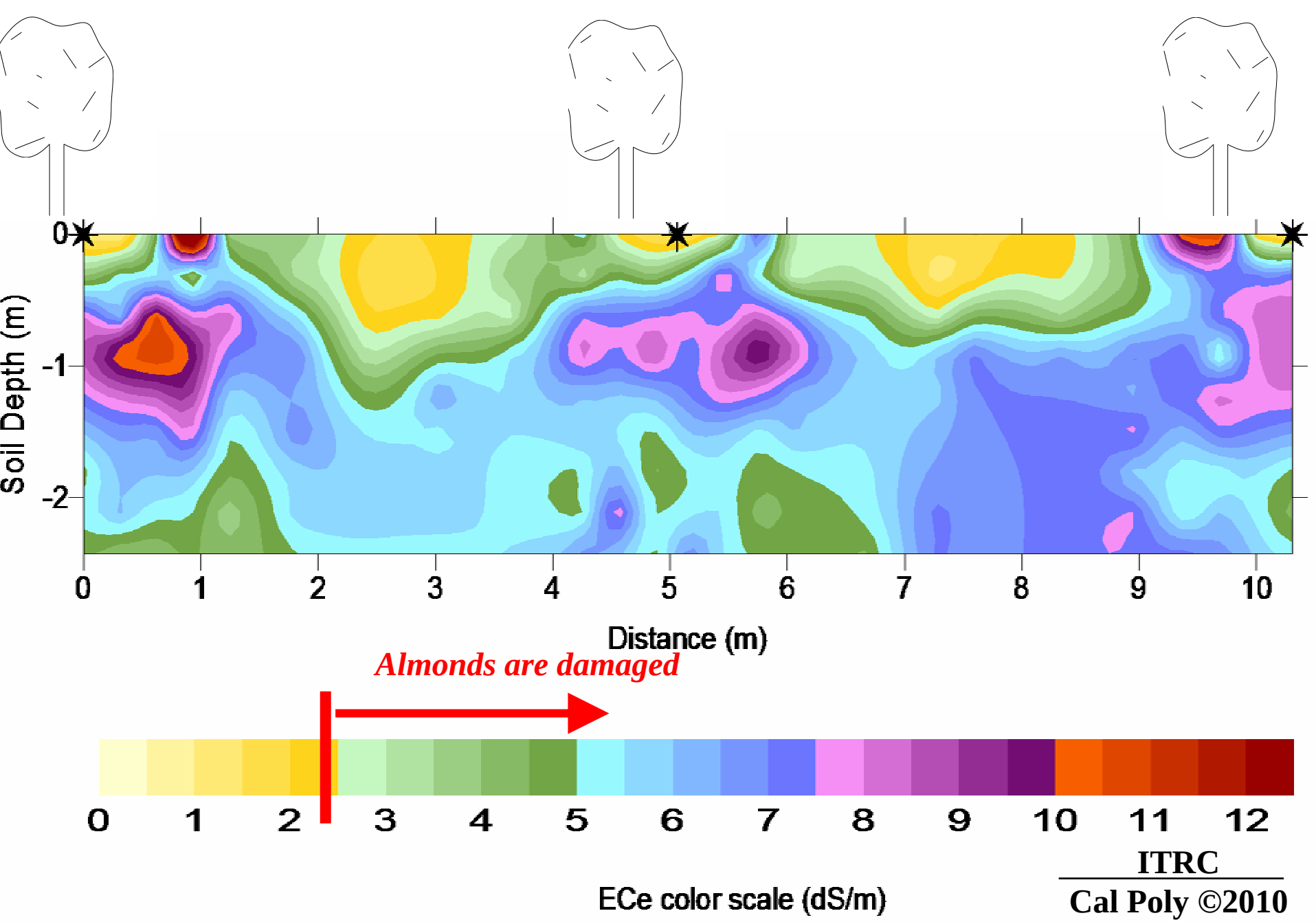
RDI

Of course, there's always some room for improvement in almost anything.

But the facts are:

1. There's already extensive under-irrigation.
2. RDI is risky.
3. RDI doesn't account for SALT leaching



Results from ITRC study on salt accumulation – typical for drip irrigated 20 yr orchard on west side SJV

Are low on-farm irrigation efficiencies the cause of our water volume problems?

Fact: Not generally in the San Joaquin Valley or Sacramento Valley. The BASIN is the correct scale to examine for true conservation.

Fact: In Imperial Valley, it's different.

Exception: Flows to local salt sinks are influenced by low on-farm efficiencies.

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Confusion between BASIN and ON-FARM efficiencies to predict reduction in water consumption is:

- Common
- Erroneous
- Harmful to good policy

Back to the hybrid vehicles that everyone drove today…

(By the way, I usually walk to work, or ride my bike. And I have solar at my house)

We know that things like:

Solar
Hybrid Vehicles
LED's
High pump efficiency

are good for the environment and save energy

We know that things like:

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Hybrid Vehicles
LED's
High pump efficiency

are good for the environment and save energy

But solar and hybrid vehicles are expensive.

Although they do not require
MANAGEMENT CHANGES

Improved on-farm water management has many advantages

BUT….

1. It generally has a cost.
2. Often, it does NOT save water for California.
3. It is much more difficult to implement than low-flush toilets or hybrid cars.

It requires intensive management.

So how are we doing, on-farm?

- Steady conversion to high-tech irrigation systems and methods.

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- Steady conversion to high-tech irrigation systems and methods.
- Improved knowledge of evapotranspiration, soil moisture management.
- Fertigation is improving but has a long way to go.
- Farmers now, in general, talk the lingo of Distribution Uniformity and Efficiency.

So how are we doing, on-farm?

- Major increases in yield/quality in some crops
  - Processing tomatoes
  - Pistachios
  - Almonds
  - Peppers
  - Lettuce (How much can we eat?)

So how are we doing, on-farm?

- Major increases in yield/quality in some crops
- We still have quite a way to go, though things are much, much more advanced than 20 years ago.

How about irrigation districts?

Huge advancements:

- Understanding water balances
- SCADA
- Modernization of delivery flexibility
- Modern ordering/billing software
- Improving conveyance efficiencies
- Better flow measurement

Irrigation Districts

- We anticipate much more modernization.
- It's very expensive.
- Right now, water transfers help to pay for much of the modernization.

This is an introduction.

Thank you.