System costs vs. design parameters

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Irrigation projects can be classified into 2 types:

1. Small – Medium size projects
2. Mega Projects

**Small – Medium Projects features:**
- Project size – up to few hundreds of Ha.
- Only one water system – Infield.

**Mega Projects features:**
- Project size – usually thousands of Ha.
- One water source may irrigate hundreds or thousands of Ha.
- A Complete water system consists on 2 major sub-systems:
  - BWS - main supply system up to secondary (irrigation) pump stations / head controls
  - Infield irrigation – the routine systems for irrigating the sub-areas
BWS MAJOR COMPONENTS:

- Primary pump station
BWS MAJOR COMPONENTS:

- Big diameter piping system / water canals
BWS MAJOR COMPONENTS:

- Water reservoirs – construction & lining
Parameters effecting system’s cost

Agronomic parameters:
- Max. daily return – mm/day (BWS & Infield)
- Type of soil – dripper spacing for germination (Infield only)
- Rows spacing / planting, dual row vs. single row (Infield only)
- Planting / harvesting program & schedule (BWS only)

Area and technical parameters:
- Size and shape of area and blocks (BWS & Infield)
- Topography (BWS & Infield)
- Location of water source (BWS & Infield)
- Flow rate of dripper – application rate (Infield only)
- Operational parameters - road spacing, valves clusters, flushing manifolds (Infield only)
- Wall thickness of driplines - dripline & freight (Infield only)
- Energy / investment optimization (BWS & Infield)
Typical cost proportions for Low cost row crop system – 64Ha sample design
(no flushing manifolds)

<table>
<thead>
<tr>
<th></th>
<th>Hardware ($)</th>
<th>Installation ($)</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Equipment</td>
<td>17,570</td>
<td>7,815</td>
<td>20,370</td>
</tr>
<tr>
<td>Head control</td>
<td>20,290</td>
<td></td>
<td>25,305</td>
</tr>
<tr>
<td>Infield head work</td>
<td>7,390</td>
<td>1,410</td>
<td>8,800</td>
</tr>
<tr>
<td>Mains &amp; header networks</td>
<td>22,860</td>
<td>14,380</td>
<td>37,240</td>
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<tr>
<td>In filed network</td>
<td>46,750</td>
<td>9,260</td>
<td>56,010</td>
</tr>
<tr>
<td>Automation control</td>
<td>7,710</td>
<td>600</td>
<td>8,310</td>
</tr>
<tr>
<td>Total cost</td>
<td>122,570</td>
<td>33,465</td>
<td>156,035</td>
</tr>
<tr>
<td>Cost ($/Ha)</td>
<td>1,915</td>
<td>523</td>
<td>2,438</td>
</tr>
</tbody>
</table>
Parameters effecting system’s cost

Agronomic parameters (1):

- **Max. daily return – mm/day (BWS & Infield)**
  - Strong impact – effects all components except driplines:
  - 25% increase in daily return (6mm → 7.5mm) =
    - ~ 8% -10% increase in Infield cost
    - ~ 15% -18% increase in BWS cost
    - ~ 12% increase in total cost

- **Type of soil – dripper spacing for germination (Infield only)**
  - Small impact – effects mostly driplines cost:
  - 20% decrease in spacing (50cm → 40cm) =
    - ~ 5% increase in Infield cost
      (assuming one more shift)
    - ~ 2.7% increase in total cost
Parameters effecting system’s cost

Agronomic parameters (2):

- Rows spacing / planting, dual row vs. single row (Infield only)
  - Small impact – effects mostly driplines cost:
  - 33% increase in driplines spacing (1.5m → 2.0m) =
    - ~ 9% decrease in Infield cost (assuming one less shift)
    - 0% decrease in BWS cost
    - ~ 5% decrease in total cost
Parameters effecting system’s cost

Agronomic parameters (3):

- **Planting / harvesting program & schedule (BWS only)**
  - Small – Medium impact – effects total flow of BWS:
  - assuming scattered planting program and thus 25% reduction in water return (6mm → 4.5mm) =
    - 0% decrease in Infield cost
    - ~ 15% decrease in BWS cost
    - ~ 6 - 7% decrease in total cost
Parameters effecting system’s cost

Area and technical parameters (1):

- **Size and shape of area and blocks (BWS & Infield)**
  - Medium impact – effects piping diameters & lengths:
  - 30% more sub mains, 20% more mainlines and supply lines =
    - ~ 6.5% increase in Infield cost
    - ~ 15% increase in BWS cost
    - ~ 10% increase in total cost
Parameters effecting system’s cost

Area and technical parameters (2):

- **Topography (BWS & Infield)**
  - Can have strong impact – effects piping class, pumping & energy, but, “not in our hands”
  - Size of increase depends on topography =
    - ~4% - 20% increase in Infield cost
    - ~4% - 30% increase in BWS cost
    - ~4% - 25% increase in total cost

- **Location of water source (BWS & Infield)**
  - Can have very strong impact (up to hundreds of %) – effects piping length & class, pumping & energy, operational reservoirs, but, “not in our hands”
General design of BWS: CSS - Senegal
Parameters effecting system’s cost

Area and technical parameters (3):

- Flow rate of dripper – application rate (Infield only)
  - Small impact – effects piping & valves and Automation cost:
  - Decrease of drippers flow (1.6l/h → 1.0l/h or 1.0l/h → 0.6l/h) =
    - ~4% decrease in Infield cost
    - 0% increase in BWS cost
    - ~2% decrease in total cost

- Wall thickness of driplines (Infield only)
  - Medium-high impact – effects driplines & freight cost:
  - Max increase in drippers w/t (150 mil → 1mm) =
    - ~13% increase in Infield cost + 70% in freight cost
    - 0% increase in BWS cost
    - ~7% + 2.5% = ~10% increase in total cost
Parameters effecting system’s cost

Area and technical parameters (4):

- Operational parameters - road spacing, valves clusters, flushing manifolds (Infield only)
  - Small impact – effects piping, valves and Automation:
  - Utilizing valves clusters (3 – 5 valves per cluster) =
    - ~4% increase in Infield cost,
    - ~2% increase in total cost
  - Utilizing flushing manifolds for driplines
    (~4 valves per block) =
    - ~3% increase in Infield cost,
    - ~1.5% increase in total cost
Parameters effecting system’s cost

Area and technical parameters (5):

- Energy vs. investment optimization (BWS & Infield)
  - Small impact – effects piping and pumps:
  - Reducing flow velocity and choosing high efficiency pump =
    - ~6% increase in Infield cost
    - ~10% increase in BWS cost
    - ~8% increase in total cost
How can we reduce investment & running costs?

- Area division into Subunits - Netafim designer should be involved with this process
  - **Irrigation Zones = Pump Stations zones**
    - As close as possible to square shape with P.S. in the center – cost & fertilizer Distribution.
    - Total area range per PS: ~ 250 – 600Ha
    - Total of 12 PS zones
  - **Subareas**
    - 2 – 4 subareas per PS zone
    - One S.A. size (modularity of H.C. & Fert.): 100 – 150 Ha
    - S.A. to be located as close as possible to P.S.
    - Shape of S.A. to be as close as possible to square – cost & fertilizers distribution
Master Plan / Area Division into Subunits / Bulk Water Supply

LEGEND
- ESTATE BOUNDARY
- OUTGROWERS BOUNDARY
- MAIN ROAD
- CANAL
- BULK WATER SUPPLY MAINLINE
- CLUSTER MAINLINE
- CLUSTER
- POWERLINE
- PUMPSTATION
- BALANCING DAM
- ETHANOL PLANT

AREAS
- ESTATE = 30432Ha
- IRRIGATION DEVELOPMENT = 23773Ha
- OUTGROWERS = 10824Ha
  - PHASE 1 = 1540Ha
  - PHASE 2 = 3827Ha
  - PHASE 3 = 4347Ha
  - PHASE 4 = 7006Ha
  - PHASE 5 = 7062Ha
• **Irrigation Blocks**
  
  - Optimal area size: 7.0 Ha – 15 Ha
  - Block width: To be adjusted to max dripline run (operational ease, cost), considering flushing
Concentrated Head controls at one pump station:

- All H.C. located at **PS structure** for the following reasons:
  - Cost saving on power supply systems
  - Central and easy to operate and control.
  - Cost saving on structures and fertilizers mobilizing
  - Improved security and safety (damage, thefts, etc.)
- One complete H.C. per Sub-Area with **independent** mainline
Valves Clusters & Secondary filters

- Recommendation: 2 – 4 valves per cluster (+ Secondary filter?)
- Operational & maintenance ease (filter flushing, automation, valves & pressures adjusting and monitoring)
- Subsurface valve fig. for infield location vs. cluster house on main roads.
- Valves location / concentration – operation & investment compromise
Cluster house – Simuney style
5 major subjects influencing project viability from Technical/Engineering perspective

- Uniformity of irrigation
- Operation & maintenance cost and ease
- Energy consumption & optimization
- Professional back-up and field service of prime contractor / supplier
- Farm management / monitoring
1. Uniformity of irrigation

- **Water application efficiency**
  - Shortage, water logging, cost of pumping

- **Fertilizer application efficiency**
  - Cost of annual fertilizer application per Ha: 500 – 550 $
  - Average FV of 15% = ~ 40 $/Ha per year
  - Total annual cost of low uniformity application per 5000 Ha project = ~ 200,000$

- **Energy consumption** – save or yield increase
2. Operation & maintenance cost and ease

- **Modular equipment & solution**
  - Uniformity of products – stock size, errors

- **Minimizing operating staff**
  - Auto. Control & monitoring.
  - Concentration of H.C. & Primary filters at PS
  - Concentration of valves & secondary filters at clusters
  - Pre-treatment for irrigation water if quality is poor.

- **Minimizing maintenance work and staff**
  - High quality Electro-Mechanical equipment
  - Long distance 20 - 22mm dripline run result in min. number of endlines to flush and max. flushing velocity.
  - Installation of flushing manifolds and valves to facilitate flushing.
3. Energy consumption & optimization

- High efficiency pumps & motors (83 – 85% vs. 72 – 75%): 13.5% energy save
- As equal as possible shifts flow rate: ~ 5% energy save
- Higher diameters of mainline & submains: ~ 6% energy save
- 20 - 22mm drip line diameter vs. 16mm: 15 - 18% energy save
- Drippers clogging / uniformity: 5 – 10% energy save
- Safety factor: 5% – 10%?
- Filters back-flushing volume: 2 – 3% water / energy save.
4. Global irrigation management

- Automation
- Online real feedback of operational data on site
  + alarm sending (radio, cellular..)
- GIS
THANK YOU