

## Supplementary data: Algorithms Performance Assessment

### 1. Open Furrows Irrigation System

Table A1 to A4 illustrates the summary of fitness functions, performance parameter properties, and evolve parameters achieved by both algorithms, for 10 runs each for open furrows system. It is clearly that  $\epsilon$ -DSEA performance is better than Borg MOEA in almost all case.

**Table A1.** Results summary of open furrows system for 10 optimisation runs.

	Borg MOEA				$\epsilon$ -DSEA			
	Best	Mean	Median	Std.	Best	Mean	Median	Std.
12 months (one year)								
Min. $f_{Del-GW}$	<b>0.002</b>	<b>0.006</b>	<b>0.005</b>	0.006	0.003	0.007	0.006	<b>0.003</b>
Max. $f_{Del-GW}$	1.275	1.184	1.192	0.071	<b>1.335</b>	<b>1.258</b>	<b>1.244</b>	<b>0.054</b>
Min. $f_{WL}$	0.168	0.248	0.274	0.057	<b>0.147</b>	<b>0.176</b>	<b>0.161</b>	<b>0.032</b>
Max. $f_{WL}$	<b>7.870</b>	7.430	<b>7.547</b>	0.456	7.814	<b>7.446</b>	7.426	<b>0.244</b>
Min. $f_{mining}$	12.141	12.145	12.145	0.003	<b>12.138</b>	<b>12.141</b>	<b>12.142</b>	<b>0.002</b>
Max. $f_{mining}$	12.258	<b>12.256</b>	12.257	0.002	<b>12.257</b>	<b>12.256</b>	<b>12.256</b>	<b>0.001</b>
60 months (5 years)								
Min. $f_{Del-GW}$	<b>0.795</b>	<b>0.952</b>	<b>0.916</b>	0.145	0.884	1.057	1.057	<b>0.094</b>
Max. $f_{Del-GW}$	6.746	5.366	5.362	0.614	<b>7.238</b>	<b>6.242</b>	<b>6.248</b>	<b>0.425</b>
Min. $f_{WL}$	1.627	2.085	2.050	0.314	<b>1.142</b>	<b>1.433</b>	<b>1.476</b>	<b>0.117</b>
Max. $f_{WL}$	13.278	<b>11.512</b>	<b>11.606</b>	1.356	<b>13.253</b>	11.125	10.758	<b>1.153</b>
Min. $f_{mining}$	65.034	65.083	65.077	0.038	<b>65.021</b>	<b>65.055</b>	<b>65.050</b>	<b>0.023</b>
Max. $f_{mining}$	68.173	67.671	67.656	0.282	<b>68.288</b>	<b>67.998</b>	<b>67.973</b>	<b>0.199</b>
120 months (10 years)								
Min. $f_{Del-GW}$	2.479	3.052	2.952	0.566	<b>2.157</b>	<b>2.492</b>	<b>2.490</b>	<b>0.237</b>
Max. $f_{Del-GW}$	8.760	7.553	7.599	0.628	<b>10.504</b>	<b>9.410</b>	<b>9.371</b>	<b>0.539</b>
Min. $f_{WL}$	5.973	6.690	6.387	0.811	<b>4.071</b>	<b>4.341</b>	<b>4.329</b>	<b>0.222</b>
Max. $f_{WL}$	<b>21.836</b>	17.949	18.121	2.609	20.579	<b>18.483</b>	<b>18.420</b>	<b>1.391</b>
Min. $f_{mining}$	143.075	143.640	143.648	0.486	<b>142.701</b>	<b>143.186</b>	<b>143.169</b>	<b>0.240</b>
Max. $f_{mining}$	155.345	153.585	153.438	1.231	<b>159.340</b>	<b>158.315</b>	<b>158.254</b>	<b>0.591</b>
300 months (25 years)								
Min. $f_{Del-GW}$	8.895	10.167	10.183	0.796	<b>7.094</b>	<b>8.032</b>	<b>7.988</b>	<b>0.560</b>
Max. $f_{Del-GW}$	18.724	16.263	15.988	1.009	<b>21.303</b>	<b>19.354</b>	<b>18.922</b>	<b>0.982</b>
Min. $f_{WL}$	18.884	20.358	19.934	1.218	<b>11.699</b>	<b>12.854</b>	<b>12.839</b>	<b>0.783</b>
Max. $f_{WL}$	37.172	34.345	34.877	<b>2.011</b>	<b>42.627</b>	<b>37.768</b>	<b>37.521</b>	2.385
Min. $f_{mining}$	532.802	545.671	544.399	8.624	<b>523.548</b>	<b>529.385</b>	<b>528.478</b>	<b>4.084</b>
Max. $f_{mining}$	675.967	649.098	649.679	<b>13.436</b>	<b>798.476</b>	<b>766.563</b>	<b>765.451</b>	15.453

**Table A2.** performance parameters properties for Borg MOEA achieved in open furrows system.

		<b>1 year</b>	<b>5 years</b>	<b>10 years</b>	<b>25 years</b>	<b>Total</b>
Sum.	Archive size	<b>66963</b>	<b>37556</b>	54725	34797	194041
Min.		<b>6320</b>	3038	3885	2371	
Max.		<b>7032</b>	<b>4317</b>	7080	4648	
Mean		<b>6696</b>	<b>3756</b>	5473	3480	
Median		<b>6701</b>	<b>3780</b>	5478	3343	
Std.		204.141	361.439	971.917	795.836	
Sum.	Improvement	<b>371101</b>	<b>585729</b>	<b>978840</b>	859199	<b>2794869</b>
Min.		<b>30944</b>	<b>51872</b>	<b>78789</b>	65581	
Max.		<b>43826</b>	<b>66420</b>	<b>118202</b>	105095	
Mean		<b>37110</b>	<b>58573</b>	<b>97884</b>	85920	
Median		<b>37342</b>	<b>58382</b>	<b>98057</b>	84265	
Std.		3557.913	4908.233	10043.333	13661.385	
Sum.	Restart	310	591	581	720	2202
Min.		29	55	55	68	
Max.		33	67	65	77	
Mean		31	59	58	72	
Median		31	59	58	72	
Std.		1.183	3.807	2.587	2.408	
Sum.	CPU time (sec)	568.265	877.378	1469.572	8209.707	11124.922
Min.		53.377	79.134	126.409	734.016	
Max.		59.240	93.327	167.043	871.391	
Mean		56.826	87.738	146.957	820.971	
Median		57.180	88.593	149.110	830.377	
Std.		2.148	<b>4.532</b>	16.263	<b>46.260</b>	

**Table A3.** performance parameters properties for  $\epsilon$ -DSEA achieved in open furrows system.

		<b>1 year</b>	<b>5 years</b>	<b>10 years</b>	<b>25 years</b>	<b>Total</b>
Sum.	Archive size	53169	36567	<b>79807</b>	<b>76095</b>	<b>245638</b>
Min.		5158	<b>3283</b>	<b>7152</b>	<b>6848</b>	
Max.		5429	4267	<b>8461</b>	<b>8547</b>	
Mean		5317	3657	<b>7981</b>	<b>7610</b>	
Median		5370	3684	<b>8013</b>	<b>7495</b>	
Std.		<b>108.093</b>	<b>284.286</b>	<b>372.909</b>	<b>456.591</b>	
Sum.	Improvement	234578	352912	768156	<b>1125810</b>	2481456
Min.		22447	31548	71432	<b>101135</b>	
Max.		24532	38994	81593	<b>122042</b>	
Mean		23458	35291	76816	<b>112581</b>	
Median		23343	35422	76689	<b>114350</b>	
Std.		<b>696.266</b>	<b>2105.599</b>	<b>3061.316</b>	<b>6723.207</b>	
Sum.	Restart	<b>30</b>	<b>29</b>	<b>29</b>	<b>32</b>	<b>120</b>
Min.		<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	
Max.		<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	
Mean		<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	
Median		<b>3</b>	<b>3</b>	<b>3</b>	<b>4</b>	
Std.		<b>0.775</b>	<b>0.831</b>	<b>0.700</b>	<b>0.872</b>	
Sum.	CPU time (sec)	<b>288.528</b>	<b>617.214</b>	<b>1167.547</b>	<b>5642.663</b>	<b>7715.952</b>
Min.		<b>27.041</b>	<b>54.741</b>	<b>107.833</b>	<b>497.632</b>	
Max.		<b>31.604</b>	<b>71.502</b>	<b>124.593</b>	<b>662.459</b>	
Mean		<b>28.853</b>	<b>61.721</b>	<b>116.755</b>	<b>564.266</b>	
Median		<b>28.672</b>	<b>62.169</b>	<b>116.255</b>	<b>562.720</b>	
Std.		<b>1.318</b>	5.026	<b>5.070</b>	51.423	

Table A4. Summary of  $\epsilon$ -DSEA evolve parameters achieved in open furrows system.

Parameters	No. of years	Minimum	Maximum	Mean	Median	Std.
$\eta$ (SBX)	1	0	70.000	63.931	69.000	17.400
	5	0	96.000	71.591	75.000	19.025
	10	0	98.000	60.574	65.000	28.033
	25	0	98.000	68.359	82.000	30.824
$CR, F$ (DE)	$CR-1$	0.100	0.167	0.105	0.100	0.015
	$F-1$	0.500	0.583	0.515	0.503	0.023
	$CR-5$	0.100	0.737	0.117	0.100	0.098
	$F-5$	0.500	0.868	0.521	0.507	0.057
	$CR-10$	0.100	0.907	0.440	0.222	0.362
	$F-10$	0.500	0.954	0.704	0.611	0.196
	$CR-25$	0.100	0.904	0.465	0.125	0.378
	$F-25$	0.500	0.952	0.718	0.563	0.204
$\sigma_\eta, \sigma_\zeta$ (PCX)	1	0.100	0.268	0.215	0.218	0.028
	5	0.100	0.274	0.203	0.202	0.014
	10	0.100	0.278	0.186	0.192	0.025
	25	0.100	0.282	0.181	0.189	0.021
$\lambda$ (SPX)	1	2.532	3.406	2.871	2.867	0.103
	5	2.505	3.115	2.952	2.979	0.082
	10	2.502	3.398	3.087	3.076	0.119
	25	2.503	3.412	3.086	3.066	0.089
$\sigma_\eta, \sigma_\zeta$ (UNDX)	$\sigma_\zeta -1$	0.400	0.500	0.406	0.401	0.010
	$\sigma_\eta -1$	0.100	0.350	0.110	0.101	0.018
	$\sigma_\zeta -5$	0.400	0.582	0.455	0.408	0.077
	$\sigma_\eta -5$	0.100	0.404	0.192	0.113	0.129
	$\sigma_\zeta -10$	0.400	0.581	0.479	0.432	0.076
	$\sigma_\eta -10$	0.100	0.402	0.231	0.153	0.126
	$\sigma_\zeta -25$	0.400	0.581	0.505	0.557	0.078
	$\sigma_\eta -25$	0.100	0.402	0.274	0.361	0.129

## 2. Drip Irrigation System

The results summary of drip irrigation system was presented in Table A5 to A8. The  $\epsilon$ -DSEA performance is superior Borg MOEA in almost all cases except for five years. However, the results are very close in that case. Hence, in general,  $\epsilon$ -DSEA is outperform in this alternative and its results will be adopted.

**Table A5.** Results summary of drip system for 10 optimisation runs.

	Borg MOEA				$\epsilon$ -DSEA			
	Best	Mean	Median	Std.	Best	Mean	Median	Std.
12 months (one year)								
Min. $f_{Del-GW}$	<b>0.001</b>	<b>0.002</b>	<b>0.002</b>	<b>0.001</b>	0.002	0.003	0.003	<b>0.001</b>
Max. $f_{Del-GW}$	<b>0.547</b>	0.521	0.528	0.022	0.543	<b>0.531</b>	<b>0.531</b>	<b>0.006</b>
Min. $f_{WL}$	0.145	0.152	0.149	0.007	<b>0.144</b>	<b>0.146</b>	<b>0.146</b>	<b>0.001</b>
Max. $f_{WL}$	<b>2.308</b>	2.063	2.066	<b>0.104</b>	2.276	<b>2.119</b>	<b>2.149</b>	0.108
Min. $f_{mining}$	<b>12.119</b>	12.121	12.121	0.002	<b>12.119</b>	<b>12.120</b>	<b>12.120</b>	<b>0.001</b>
Max. $f_{mining}$	<b>12.201</b>	<b>12.200</b>	<b>12.200</b>	<b>0.001</b>	<b>12.201</b>	<b>12.200</b>	<b>12.200</b>	<b>0.001</b>
60 months (5 years)								
Min. $f_{Del-GW}$	<b>0.242</b>	<b>0.337</b>	<b>0.348</b>	<b>0.047</b>	0.293	0.436	0.436	0.099
Max. $f_{Del-GW}$	<b>3.948</b>	<b>3.615</b>	<b>3.668</b>	0.270	3.458	3.197	3.159	<b>0.148</b>
Min. $f_{WL}$	0.923	1.092	1.067	0.124	<b>0.885</b>	<b>1.041</b>	<b>1.074</b>	<b>0.098</b>
Max. $f_{WL}$	<b>5.532</b>	<b>4.541</b>	<b>4.481</b>	0.427	4.600	4.102	4.006	<b>0.343</b>
Min. $f_{mining}$	<b>64.567</b>	<b>64.599</b>	<b>64.599</b>	0.025	64.590	64.608	64.607	<b>0.013</b>
Max. $f_{mining}$	66.559	66.306	66.233	0.151	<b>66.879</b>	<b>66.717</b>	<b>66.730</b>	<b>0.128</b>
120 months (10 years)								
Min. $f_{Del-GW}$	0.739	0.872	0.889	<b>0.095</b>	<b>0.645</b>	<b>0.772</b>	<b>0.729</b>	0.154
Max. $f_{Del-GW}$	<b>5.419</b>	<b>4.146</b>	3.997	0.594	4.892	4.109	<b>4.040</b>	<b>0.337</b>
Min. $f_{WL}$	<b>3.182</b>	3.780	3.758	0.440	3.337	<b>3.471</b>	<b>3.430</b>	<b>0.127</b>
Max. $f_{WL}$	<b>9.020</b>	<b>8.157</b>	<b>8.079</b>	<b>0.442</b>	8.616	8.006	8.053	0.530
Min. $f_{mining}$	<b>141.124</b>	141.404	141.408	0.242	141.154	<b>141.305</b>	<b>141.288</b>	<b>0.107</b>
Max. $f_{mining}$	149.547	148.070	148.191	0.906	<b>151.313</b>	<b>149.825</b>	<b>149.655</b>	<b>0.877</b>
300 months (25 years)								
Min. $f_{Del-GW}$	2.731	3.213	3.241	<b>0.267</b>	<b>2.272</b>	<b>2.663</b>	<b>2.453</b>	0.525
Max. $f_{Del-GW}$	7.596	6.742	6.837	0.640	<b>8.594</b>	<b>8.096</b>	<b>8.063</b>	<b>0.335</b>
Min. $f_{WL}$	11.098	12.139	12.311	<b>0.418</b>	<b>9.129</b>	<b>9.794</b>	<b>9.864</b>	0.529
Max. $f_{WL}$	<b>17.906</b>	<b>16.705</b>	16.522	<b>0.596</b>	17.824	16.637	<b>17.027</b>	1.439
Min. $f_{mining}$	513.838	516.958	516.020	<b>3.258</b>	<b>499.751</b>	<b>506.268</b>	<b>506.564</b>	3.363
Max. $f_{mining}$	587.806	571.068	571.196	<b>8.700</b>	<b>632.234</b>	<b>602.036</b>	<b>601.931</b>	13.128

**Table A6.** performance parameters properties for Borg MOEA achieved in drip system.

		<b>1 year</b>	<b>5 years</b>	<b>10 years</b>	<b>25 years</b>	<b>Total</b>
Sum.	Archive size	<b>15211</b>	<b>12097</b>	<b>17679</b>	22972	67959
Min.		<b>1444</b>	<b>1082</b>	1236	1739	
Max.		<b>1579</b>	<b>1307</b>	<b>2726</b>	2689	
Mean		<b>1521</b>	<b>1210</b>	<b>1768</b>	2297	
Median		<b>1520</b>	<b>1236</b>	<b>1723</b>	2274	
Std.		33.351	64.5136	391.814	<b>279.050</b>	
Sum.	Improvement	<b>113768</b>	<b>205090</b>	<b>349198</b>	<b>708199</b>	<b>1376255</b>
Min.		<b>9874</b>	<b>17998</b>	<b>30301</b>	<b>49690</b>	
Max.		<b>12793</b>	<b>23570</b>	<b>43664</b>	<b>82248</b>	
Mean		<b>11377</b>	<b>20509</b>	<b>34920</b>	<b>70820</b>	
Median		<b>11347</b>	<b>20128</b>	<b>33900</b>	<b>73724</b>	
Std.		860.136	1761.311	4117.949	9549.918	
Sum.	Restart	3795	3709	1142	781	9427
Min.		302	181	74	71	
Max.		439	499	199	108	
Mean		380	371	114	78	
Median		383	397	101	75	
Std.		44.996	85.098	39.296	10.492	
Sum.	CPU time(sec)	244.098	527.987	894.324	9097.121	10763.53
Min.		21.474	52.163	85.762	845.439	
Max.		25.688	53.770	94.312	975.618	
Mean		24.410	52.799	89.432	909.712	
Median		24.663	52.716	88.414	920.013	
Std.		1.386	<b>0.586</b>	<b>2.647</b>	<b>43.935</b>	

**Table A7.** performance parameters properties for  $\epsilon$ -DSEA achieved in drip system.

		<b>1 year</b>	<b>5 years</b>	<b>10 years</b>	<b>25 years</b>	<b>Total</b>
Sum.	Archive size	14911	11098	16776	<b>36925</b>	<b>79710</b>
Min.		1473	1038	<b>1430</b>	<b>2325</b>	
Max.		1508	1238	1933	<b>4897</b>	
Mean		1491	1110	1678	<b>3693</b>	
Median		1495	1101	1670	<b>3631</b>	
Std.		<b>9.741</b>	<b>56.377</b>	<b>150.899</b>	722.759	
Sum.	Improvement	86238	122893	220909	585776	1015816
Min.		7421	10960	19336	47654	
Max.		9139	13755	23949	67526	
Mean		8624	12289	22091	58578	
Median		8684	12461	22192	58848	
Std.		<b>455.375</b>	<b>901.671</b>	<b>1350.611</b>	<b>5671.934</b>	
Sum.	Restart	<b>31</b>	<b>31</b>	<b>28</b>	<b>26</b>	<b>116</b>
Min.		<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	
Max.		<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	
Mean		<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	
Median		<b>4</b>	<b>4</b>	<b>3</b>	<b>2</b>	
Std.		<b>0.943</b>	<b>0.943</b>	<b>0.600</b>	<b>0.800</b>	
Sum.	CPU time(sec)	<b>161.632</b>	<b>385.008</b>	<b>657.451</b>	<b>5301.796</b>	<b>6505.887</b>
Min.		<b>15.138</b>	<b>35.791</b>	<b>57.993</b>	<b>480.954</b>	
Max.		<b>16.958</b>	<b>41.926</b>	<b>68.909</b>	<b>629.137</b>	
Mean		<b>16.163</b>	<b>38.501</b>	<b>65.745</b>	<b>530.180</b>	
Median		<b>16.282</b>	<b>39.127</b>	<b>67.506</b>	<b>508.391</b>	
Std.		<b>0.608</b>	2.136	3.643	50.410	

Table A8. Summary of  $\varepsilon$ -DSEA evolve parameters achieved in drip system.

Parameters	No. of years	Minimum	Maximum	Mean	Median	Std.
$\eta$ (SBX)	1	4.000	88.000	63.874	67.000	13.199
	5	1.000	98.000	85.929	88.000	10.950
	10	1.000	94.000	60.417	65.000	25.064
	25	0	98.000	84.232	87.000	18.433
$CR, F$ (DE)	$CR-1$	0.100	0.300	0.104	0.100	0.019
	$F-1$	0.500	0.650	0.531	0.529	0.021
	$CR-5$	0.100	0.891	0.122	0.100	0.105
	$F-5$	0.500	0.946	0.537	0.523	0.059
	$CR-10$	0.100	0.912	0.203	0.100	0.250
	$F-10$	0.500	0.956	0.570	0.507	0.139
	$CR-25$	0.100	0.911	0.459	0.444	0.361
	$F-25$	0.500	0.955	0.714	0.722	0.197
$\sigma_\eta, \sigma_\zeta$ (PCX)	1	0.100	0.214	0.165	0.165	0.022
	5	0.100	0.264	0.130	0.122	0.023
	10	0.100	0.282	0.226	0.228	0.028
	25	0.100	0.282	0.192	0.193	0.015
$\lambda$ (SPX)	1	2.521	3.000	2.609	2.580	0.079
	5	2.506	3.409	2.576	2.567	0.102
	10	2.508	3.407	2.832	2.834	0.089
	25	2.502	3.409	2.940	3.003	0.149
$\sigma_\eta, \sigma_\zeta$ (UNDX)	$\sigma_\zeta -1$	0.400	0.544	0.408	0.402	0.017
	$\sigma_\eta -1$	0.100	0.350	0.114	0.103	0.029
	$\sigma_\zeta -5$	0.400	0.581	0.434	0.402	0.062
	$\sigma_\eta -5$	0.100	0.401	0.157	0.103	0.104
	$\sigma_\zeta -10$	0.400	0.580	0.470	0.413	0.082
	$\sigma_\eta -10$	0.100	0.401	0.217	0.121	0.137
	$\sigma_\zeta -25$	0.400	0.582	0.501	0.550	0.080
	$\sigma_\eta -25$	0.100	0.404	0.269	0.350	0.133