ENSURING SUSTAINABLE ARTEMISININ PRODUCTION
MEETING GLOBAL DEMAND
24-26 November 2008
Guilin, CHINA
Jacques PILLOY / OTECI-ARTEPAL
ACT Production cycle

- R.M.
- Starting Mat
- API
- ACT

Artemisia Annua

Artemisinin

DHA

Artesunate

Artemether

AS/AQ

AL

Plantation

Extraction-Pur.

Hemi-synthesis

Drug Product
### ACT Production cycle

<table>
<thead>
<tr>
<th>Month</th>
<th>1</th>
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<th>12</th>
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<tbody>
<tr>
<td>Artemisia</td>
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</tbody>
</table>
From *Artemisia annua* to Artemisinin: Estimates

- **Quantity of dried leaves A.A/ha:**
  
  1.0 – 2.5 T average **1.5 T/ha**

- **Average Artemisinin content in the leaves:**
  
  0.4 – 1 %

  Average at extraction stage: **0.6%**

- **Extraction – Purification process efficiency:**
  
  40 – 65 % Average: **50%**

- **Quantity of Artemisinin/ Ha:** average **4.5 Kg**
**Artemisinin per treatment**

- **AS/ AQ**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>&lt; 1</th>
<th>1-6</th>
<th>7-13</th>
<th>&gt; 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artesunate (mg)</td>
<td>75</td>
<td>150</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>Artemisinin eq. (mg) 5% loss</td>
<td>77</td>
<td>153</td>
<td>306</td>
<td>613</td>
</tr>
</tbody>
</table>
### Artemisinin per treatment

#### Artemether/ Lumefantrine

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>5-14</th>
<th>15-24</th>
<th>25-34</th>
<th>&gt; 34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artemether (mg)</td>
<td>120</td>
<td>240</td>
<td>360</td>
<td>480</td>
</tr>
<tr>
<td>Artemisinin eq. (mg) 5% loss</td>
<td>210</td>
<td>419</td>
<td>629</td>
<td>839</td>
</tr>
</tbody>
</table>
Artemisinin per treatment

The « average treatment » is the result of the weighting of the different dosages based on the CHAI forecast:

<table>
<thead>
<tr>
<th>Dosage</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL</td>
<td>32%</td>
<td>22%</td>
<td>14%</td>
<td>32%</td>
</tr>
<tr>
<td>AS/AQ</td>
<td>8%</td>
<td>36%</td>
<td>20%</td>
<td>36%</td>
</tr>
</tbody>
</table>
Artemisinin per treatment

- Considering the artemisinin quantity per dosage and the repartition of the different dosages, the average quantity per treatment is:
  - AL = 0.51 g artemisinin
  - AS/AQ = 0.34 g artemisinin
- These figures may change according to evolution in the repartition between dosages.
Artemisinin per treatment

- Split between AL and AS/AQ treatments is about 70/30 %.

- After all these calculations, we can roughly consider the following figure:

  1 treatment = 0.5 g Artemisinin.
From *Artemisia annua* to treatments: Estimates

- 1 ha *Artemisia annua* corresponds to:
  - 14,700 to 29,400 AS/AQ treatments
  - 9,800 to 19,600 AL treatments.

  OR

- 1 Million treatments needs:
  - For ASAQ: 34 to 68 ha
  - For AL: 51 to 102 ha
## Artemisinin Production Estimates

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Artemisia annua Surface (ha)</strong></td>
<td>2 000</td>
<td>3 000</td>
<td>9 500</td>
<td>26 000</td>
<td>14 500</td>
<td>4 500</td>
</tr>
<tr>
<td><strong>Artemisinin Quantity (T)</strong></td>
<td>8-10</td>
<td>30-40</td>
<td>60-80</td>
<td>180-200</td>
<td>100-110</td>
<td>30-40</td>
</tr>
</tbody>
</table>
ARTEMISININ PRODUCTION ESTIMATES FOR 2008

Following figures do not integrate stocks from previous campaigns.

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Vietnam</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface (ha)</td>
<td>2 000</td>
<td>1 000</td>
<td>1 500</td>
<td>5 000</td>
</tr>
<tr>
<td>Artemisinin (T)</td>
<td>12 – 20</td>
<td>6 – 8</td>
<td>10 - 15</td>
<td>30 – 40</td>
</tr>
</tbody>
</table>
Artemisinin needs forecasts
2009-2011

- Needs concerns:
  - ACT public sector
  - ACT private sector
  - AMFM
  - Artemisinin based monotherapies even if they are banned by WHO.

- Following figures wants to be simple to memorize:
## Artemisinin needs forecasts 2009-2011

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb of treatments (millions)</td>
<td>160</td>
<td>240</td>
<td>260</td>
</tr>
<tr>
<td>Artemisinine Needed (T)</td>
<td>80</td>
<td>120</td>
<td>130</td>
</tr>
<tr>
<td>Surface to be planted (ha) (4.5kg Art/ha)</td>
<td>Too late</td>
<td>26 500</td>
<td>29 000</td>
</tr>
</tbody>
</table>
Artemisinin needs forecasts 2009-2011

- To cover the needs of 2009 and beginning 2010, there is a risk of shortage.
- It will be then necessary in 2010 to reconstitute safety inventories in the supply chain.
Artemisinin needs forecasts 2009-2011

- This will need probably around 30 to 40 MT more of artemisinin for 2010! and about 8 000 ha more!
Artemisinin needs forecasts 2009-2011

- ARTEMISININ PRODUCERS WILL FACE A HUGE CHALLENGE;

- THANK YOU