



**Indicative simplified baseline and monitoring methodologies  
for selected small-scale CDM project activity categories**

**TYPE III – OTHER PROJECT TYPES**

Project participants shall take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html>.

***III.A. Urea offset by inoculant application in soybean-corn rotations on acidic soils on existing cropland*****Technology/measure**

1. This methodology covers project activities that involve the distribution and application of inoculant on soybean in a soybean-corn rotation cropping on acidic soils on existing cropland. In the absence of the project activity, soybean would have been fertilized with urea. Corn is fertilized with urea in the baseline. Corn is also fertilised with urea in the project situation, however with reduced application rates as compared to the baseline.

2. The methodology is applicable:

- (a) If the farmers participating in the project activity have grown soybean and corn in a corn-soybean rotation in the previous three complete rotations<sup>1</sup> without using any inoculant as a fertiliser for soybean, but have used urea for fertilizing soybean.
- (b) For each farmer taking part in the project activity, reliable and verifiable data on the amount of urea used, separately for each crop type, in the previous three complete rotations of corn and soybean cropping, shall be available.
- (c) No change in the types of crop cultivated takes place. In both the baseline and project situation soybean and corn are cultivated in rotations. No other changes in farming practices affecting fertilizer application, except the change in application of inoculant and urea, are taking place during the crediting period.
- (d) The project activity is accompanied by an educational programme which informs the farmers that adding any other source of N (e.g. synthetic fertilizer or organic fertilizer) on soybean is counterproductive and will make the rhizobia bacteria applied to the soil via inoculation ineffective.
- (e) Farmers that take part in the project activity sign an agreement with the project participants that specifies that:
  - (i) They did not use inoculants during the last three complete rotations;
  - (ii) They will not claim emissions reductions for using inoculant on their land;
  - (iii) The emission reductions generated by the project activity are owned by the project participants;
  - (iv) They will apply inoculant following the recommendations made by national or supra-national agricultural research organizations.

<sup>1</sup> In a two-year cropping sequence this corresponds to the previous six years. In a one-year cropping sequence this corresponds to the previous three years.



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- (f) Also wholesalers and retailers of inoculant shall sign an agreement with the project participants that specifies that the emission reductions generated by the project activity are owned by the project participants and that they will instruct farmers to apply inoculant following the recommendations made by national or supra-national agricultural research organizations.
- (g) The geographical/physical boundaries of the baseline electricity grid can be clearly identified and information pertaining to the grid and to estimate baseline emissions is publicly available.
- (h) If the project participants are able to demonstrate that in the baseline scenario urea would be purchased from in-country production facilities or imported from a producing facility located in a Non-Annex I country.

3. The most plausible baseline scenario for the project activity shall be evaluated including the assessment of the alternatives of the project activity. For the purpose of the evaluation, project participants may apply the steps 1 to 3 of the “Combined tool to identify the baseline scenario and demonstrate additionality” to identify the baseline scenario. If the identified baseline scenario is the same as the baseline of the methodology, i.e. the continued application of urea on soybean and corn at the historical rates, as described above in paragraph 1) and 2), and it can be demonstrated that the implementation of the project activity as ‘the proposed project activity undertaken without being registered as CDM’, is not the common practice in the region, project participants can apply this methodology.

4. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO<sub>2</sub> equivalent annually.

5. For the purpose of this methodology the following definitions apply:

**Inoculation:** The practice of introducing rhizobia strains into the soil-plant ecosystem (via crop seeds) in soils where no rhizobia is present, the number of rhizobia is insufficient to achieve the desired soybean yield and/or the rhizobia strains contained in the soil are ineffective.

**Rhizobia bacteria:** (*Rhizobium*, *Bradyrhizobium*, *Mesorhizobium*, *Sinorhizobium* and *Azorhizobium*): Bacteria that have the ability to form a symbiosis with legume species such as soybean. During the symbiosis, nodules (root cells invaded by rhizobia bacteria) are formed on the roots of the legumes. The rhizobia bacteria in the nodules convert gaseous nitrogen to ammonia via the nitrogenase enzyme (biological nitrogen fixation).

**Soybean-corn rotation:** A cropping sequence on a particular field that includes soybean and corn over a particular time interval (usually many years). The great majority of soybean-corn rotations have a two-year cropping sequence (one year soybean and the next year corn). In some parts of the world, a one-year cropping sequence may be found (summer soybean and winter corn).

**Crop:** Cultivated plants or agricultural produce to be harvested as food, livestock fodder or for another economic purpose, considered as a group.



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**Existing cropland:** Land on which crops have been grown over the past ten years (at least for the majority of the period).

**Acidic soil:** Soil having a pH-level below 5.5.

6. The classification of land areas shall be based on the following classification system:

**Table 1: Classification system of land areas**

Factor	Unit	Classification	Remark	Reference
Soil organic carbon content	%	1. <1 2. 1 to 3 3. >3	1. Low 2. Medium 3. High	See Stehfest <sup>2</sup> (2005)
Soil pH	-	1. <5.5 2. 5.5 - 7.3 3. >7.3	1. Acidic 2. Neutral 3. Alkaline	See Stehfest <sup>2</sup> (2005)
Soil texture	Type	1. Coarse 2. Medium 3. Fine	1. Sandy, loamy sandy, sandy loam, silt loam, silt 2. Sandy clay loam, clay loam, silty clay loam 3. Sandy clay, silty clay, clay	See Stehfest <sup>2</sup> (2005)
Climate	Type	1. Boreal 2. Cold temperate dry 3. Cold temperate wet 4. Warm temperate 5. Moist 6. Tropical dry 7. Tropical moist 8. Tropical wet		See IPCC <sup>3</sup> (2006)
Soil moisture (soil drainage)	-	1. Well drained 2. Poorly drained		See Stehfest <sup>2</sup> (2005)

### Boundary

7. The project boundary encompasses the physical, geographical location of each area of cropland where the soybean-corn rotation takes place and inoculant is applied to soybean and urea is applied to corn. It also encompasses the production facility from where the inoculant used in the project activity is sourced.

<sup>2</sup> Stehfest, E. (2005): Modelling of global crop production and resulting N<sub>2</sub>O emissions. Dissertation. University of Kassel.

<sup>3</sup> IPCC (2006): IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories.



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**Baseline**

8. Baseline emissions consist of CO<sub>2</sub> emissions from urea production. The baseline is based on the quantity of urea that each farmer would have applied in the absence of the project activity to grow soybean and corn. It shall be determined based on farmers' records of the previous three complete rotations for corn and soybean.

9. The urea application rates to corn and soybean used for baseline calculations shall not exceed the fertilizer application rates recommended by national institutions; recommendations of international organisations (like FAO) for the specific country and soil type may be used if recommendations from national institutions/authorities are not available.

10. The CO<sub>2</sub> baseline emissions from the production of fertilizer applied on soybean per farmer *i* per classified land area *j* are calculated as follows:

$$BE_{u,soy,i,j} = ha_{soy,i,j} * AR_{u,soy,i,j} * EF_{CO2,urea} \quad (1)$$

Where:

EF<sub>CO2,urea</sub> Emission factor for the production of urea (use local values or IPCC values or values from scientific literature<sup>4</sup>) (tCO<sub>2</sub>/tonne urea)

BE<sub>u,soy,i,j</sub> CO<sub>2</sub> baseline emissions from the production of urea applied on soybean per farmer *i* per classified land area *j* (tCO<sub>2</sub>)

ha<sub>soy,i,j</sub> Area of land where inoculant is applied to soybean by farmer *i* in classified land area *j* (ha)

AR<sub>u,soy,i,j</sub> Average application rate of urea to soybean by farmer *i* in classified land area *j* in the previous three complete rotations before joining the project (tonne/ha)

11. The CO<sub>2</sub> baseline emissions from the production of fertilizer applied on corn with urea per farmer *i* per classified land area *j* are calculated as follows:

$$BE_{u,corn,i,j} = ha_{corn,i,j} * AR_{u,corn,i,j} * EF_{CO2,urea} \quad (2)$$

Where:

BE<sub>u,corn,i,j</sub> CO<sub>2</sub> baseline emissions from the production of urea applied on corn per farmer *i* per classified land area *j* (tCO<sub>2</sub>)

ha<sub>corn,i,j</sub> Area of land where urea is applied to corn by farmer *i* in classified land area *j* (ha)

<sup>4</sup> In the absence of reliable project specific data, a conservative value from referenced scientific literature may be used (0.42 tCO<sub>2</sub>e/tonne urea is recommended in Wood, S. and Cowie, A.: A Review of GHG Emission Factors for Fertiliser Production (2004).

[http://www.ieabioenergy-task38.org/publications/GHG\\_Emission\\_Fertilizer%20Production\\_July2004.pdf](http://www.ieabioenergy-task38.org/publications/GHG_Emission_Fertilizer%20Production_July2004.pdf))



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$AR_{u,corn,i,j}$  Average application rate of urea applied to corn by farmer  $i$  in classified land area  $j$  in the previous three complete rotations before joining the programme (tonne/ha).

12. The total CO<sub>2</sub> baseline emissions from urea production are determined as follows:

$$BE_y = \sum_{i,j} BE_{u,soy,i,j} + \sum_{i,j} BE_{u,corn,i,j} \quad (3)$$

Where:

$\Sigma_i$  Sum of farmers  $i$  which take part in the project activity

$\Sigma_j$  Sum of classified land areas  $j$  where inoculant is applied in the project activity

$BE_y$  Total baseline emissions in year  $y$  (tCO<sub>2</sub>e)

### **Project activity emissions**

13. Project activity emissions consist of CO<sub>2</sub> emissions from the production of inoculant applied on soybean and CO<sub>2</sub> emissions from the production of urea applied on corn. Project emissions are determined as follows:

$$PE_y = \sum_i Q_{inoc} * EF_{CO2,inoc} + \sum_j Q_{urea} * EF_{CO2,urea} \quad (4)$$

Where:

$Q_{inoc}$  Amount of inoculant applied to soybean by farmer  $i$  in the project activity (number of rhizobia bacteria)

$EF_{CO2,inoc}$  Emission factor for production of inoculant (tCO<sub>2</sub>/unit of rhizobia bacteria)

$Q_{urea}$  Amount of urea applied to corn by farmer  $i$  in the project activity (tonne)

$PE_y$  Total project emissions in year  $y$  (tCO<sub>2</sub>e)

The amount of urea and inoculant applied by the farmers shall be based on farmers records for corn and soybean cropping and shall be cross-checked with records from inoculant suppliers, seed suppliers and urea suppliers.

14. The emission factor for production of inoculant ( $EF_{CO2,inoc}$ ) shall be determined as:

- Aggregate annual CO<sub>2</sub> emissions from fossil fuel use and electricity consumption in the inoculant production facility from which the inoculant for the project activity is sourced, which is calculated as follows:
  - All steps in the inoculant production process that require energy consumption shall be included, e.g. peat drying, peat grinding, peat and inoculant packaging, peat injection, fermentation, sterilization, liquid harvest and plant heating/cooling.
  - For the emissions from fossil fuel consumption the emission factor for the fossil fuel shall be used. Local values are to be used, if local values are difficult to obtain, IPCC default values may be used.



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- Emissions from electricity consumption are determined as per the procedures described in AMS I.D.
- The aggregate annual CO<sub>2</sub> emissions is divided by the annual amount of rhizobia bacteria produced by the inoculant production facility to calculate the emission factor for production of inoculant (EF<sub>CO<sub>2</sub>, inoc</sub>).

### **Leakage**

15. Leakage is to be considered (LE<sub>y</sub>), if peat (a type of inoculant carrier) is dried at a facility, which is not included in the project boundary. In this case, the type and amount of energy required for peat drying shall be collected from the peat-drying facility. Each energy form is multiplied by an emission coefficient. For electricity, the emission coefficient is calculated in accordance with provisions under category I.D. For the emissions from fossil fuel consumption the emission factor for the fossil fuel shall be used. Local values are to be used, if local values are difficult to obtain, IPCC default values may be used. The calculated leakage emissions shall be deducted from the emission reductions.

### **Monitoring**

16. For each farmer *i* taking part in the project activity the historic urea application rate for soybean and corn separately in the previous three complete rotations shall be established before joining the project activity. Also the yield per crop per hectare during the last three complete rotations shall be established. It shall be verified that no inoculant was used for fertilization of soybean in the previous three complete rotations.

17. Monitoring shall include all farmers *i* that take part in the project activity. The following parameters shall be monitored:

- Ha of crop planted;
- Classification of each land area *j* according to classification system of paragraph 5;
- The quantity of inoculant applied by the project activity (number of rhizobia bacteria);
- Amount of urea applied;
- Amount of other fertilizers applied (chemical fertilizers as well as organic fertilizers);
- Crop yield per crop per hectare.

Farmers' records (separately by crop type and land area *j*) shall be used along with other means for monitoring the above parameters.

18. It shall randomly be verified whether the farmers took part in an educational programme concerning application of inoculants (see applicability condition 2 (d)) and whether inoculant has been applied following the recommendations made by national or supra-national agricultural research organizations (see applicability condition 2 (e)).



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19. Farmers' records shall be cross-checked with records from inoculant suppliers, seed suppliers, other chemical fertilizer suppliers and urea suppliers. In case of discrepancies between the records of the farmers and those from inoculant supplies, seed suppliers or urea suppliers the most conservative value shall be taken.

20. In order to monitor whether the farmers have, contrary to the aim of the project, applied urea or other chemical or organic fertilizers to the soybean, it shall be checked by an independent third party whether the fields where soybean has been planted by the farmers show signs of urea/other fertilizer application. If any field of a farmer does show such signs, all the land areas of this particular farmer included in the project boundary will be excluded from the emission reductions calculation for the given year. For reasons of conservativeness it shall be ensured that at least one field of *each* farmer is randomly selected for a field visit.

21. As urea might be applied in split applications:

- The field visits shall be conducted as follows:
  - Once at planting; and
  - Again right before flowering.
- The independent third party will visit a sample of fields:
  - For the first time four weeks after planting; and
  - A second time eight weeks after planting (in case the plants should by then not have flowered the fields shall again be visited twelve weeks after planting or even sixteen weeks after planting).
- During the field visits the monitoring protocol contained in annex 1 shall be followed.
- The independent third party conducting the field visits shall be a qualified field technician or an agronomist.

22. While visiting the fields the independent third party will also check the farmers' records on use of urea, inoculant, other chemical fertilizers and organic fertilizers.

23. The origin of the urea, to ensure that the requirements under paragraph 2 (h) are met, shall be checked.

24. The total quantity of inoculant produced and the fossil fuel and/or electricity consumption of the inoculant production facility (number of rhizobia bacteria) shall be monitored.

25. The emission reduction achieved by the project activity will be determined as the difference between the baseline emissions and the project emissions and leakage.

$$ER_y = BE_y - PE_y - LE_y \quad (5)$$

Where:

$ER_y$       Emission reductions in year  $y$  ( $tCO_2e/y$ )



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LE<sub>y</sub>                  Leakage emissions in year  $y$  (tCO<sub>2</sub>e/y)

**Project activity under a programme of activities**

This methodology is also applicable to project activities under a programme of activities.



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**Annex 1**

**FIELD VISIT MONITORING PROTOCOL FOR UREA AND INOCULANT APPLICATION**

1. The following monitoring procedure shall be implemented to monitor the fields where soybean and corn is cultivated in rotations. It shall be administered by a qualified independent agronomist or field technician.
2. The agronomist will be informed when the soybean seed is being planted. Four weeks after planting, the agronomist will visit the farms and randomly select a field. Using an internationally accepted random soil sampling procedure, e.g. the procedure as described in “Soil Sampling”<sup>5</sup>, the agronomist will pull up soybean plants to observe the nodules at each sample spot.
3. The agronomist will compare the size of the nodules to a photo chart of nodules. Nodules formed in the presence of urea or other exogenous sources of fertilizer will be small and will appear weak.
4. Next, the agronomist will slice open the nodules and look at the colour inside. The agronomist will compare the colour to a photo chart showing the inside colour of nodules. If the nodules are pink to bright red, the nodules are biologically fixing nitrogen. If the nodule slices don’t have a colour or are light pink the plant has been fertilized with an exogenous source of nitrogen.
5. Summary: Plants exhibiting biological nitrogen fixation (BNF) are characterized by large, healthy nodules that, when cut open, are bright pink to red inside. Plants fertilized with urea or an exogenous source of nitrogen are characterized by small, weak nodules that, when cut open, have no colour or have a very light pink colour.
6. All observations will be recorded by the agronomist each time a field is visited and inspected.

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<sup>5</sup> “Sampling”, by Dr. H. Reetz, <http://www.rainbowplantfood.com/agronomics/efu/sampling.pdf> accessed on 14-04-2008.



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**History of the document**

Version	Date	Nature of revision
01	EB 39, Annex 13, 16 May 2008	Initial adoption