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CDM: Recommendation Form for Small Scale Methodologies (version 01)

(To be used for presenting questions/proposals/amendments to the simplified methodologies for small-scale CDM project activity categories)

Date of SSC WG meeting:	24–27 February 2009, SSC WG 19
Title/Subject (give a small title or specify the subject of your submission, maximum 200 characters):	Broadening the applicability of AMS-III.A to legume – grass rotation and additional options for fertilizer use
Indicative methodology to which your submission relates (refer the items of Appendix B of the Simplified Modalities and Procedures), if applicable.	AMS-III.A
Name of the authors of the query:	Matthias Krey Institution: Perspectives Climate Change GmbH krey@perspectives.cc Peg Armstrong-Gustafson Institution: Amson Technology peg@tmgmanagement.com

Summary of the query:

Please use the space below to summarize the query related to SSC methodologies/categories SSC Modalities and Procedures provide recommendation/analysis of the SSC WG.

Original text from PP:

As project developers, we would like to propose the following revisions to the methodology in order to broaden its application potential:

(1) Extension of applicability to any legume – grass rotation

(2) Extension of the applicability to synthetic fertilizers containing nitrogen other than urea

Ad (1) Extension of applicability to any legume – grass rotation:

The present methodology applies to a soybean – corn crop rotation pattern. Broader definition of the methodology to a legume – grass crop rotation would provide for a greater reduction in urea being used in common crop rotation patterns and not limit the methodology only to areas where corn and soybeans are grown. The result would be a greater CDM potential of the underlying project type.

Crop rotation is a planned order of specific crops planted on the same field. Crop rotation also means that succeeding crops are of a different genus, species, subspecies, or variety than the previous crop. Examples would be barley after wheat, row crops after small grains, grain crops after legumes, etc. The planned rotation sequence may be for a two- or three-year or longer period. Some of the general purposes of rotations are to improve or maintain soil fertility, reduce erosion, reduce the build-up of pests, spread the workload, reduce risk of weather damage, reduce reliance on agricultural chemicals, and increase net profits *(*see *NDSU Environmental Bulletin. Crop Rotations for Increased productivity. Dr. Michael D. Peel, EB-48. Jan. 1998).*

Because climate, soil type, extent of erosion, and suitable cash crops vary around the globe, rotation schemes vary as well. Examples are listed below for Ukraine, India and China.

Ukraine (not a CDM country, for illustration only)

Farms in Ukraine employ a variety of crop-rotation schemes, some including four or more crops, some only two. A six-year crop rotation in the winter grain region will often include two consecutive years of wheat and one season of "clean fallow," during which no crop is sown. The chief reason for including fallow in the rotation is to replenish soil-moisture reserves, and it is more widely used in southern eastern Ukraine where drought is not uncommon. A typical crop sequence might be: fallow, winter wheat, winter wheat, sunflowers, spring barley, and corn. Wheat almost always follows fallow. According to farm directors, this enables the wheat -- which is typically the priority crop -- to benefit from the reduced weed infestation. (Fields are cultivated several times during the fallow season.). Some crop rotations include several consecutive years of a forage crop. An example of such a rotation would be: fallow, two years of winter wheat, and four years of perennial forage. The perennial forage is usually alfalfa; farmers will get three to four cuttings per year, five if the crop is irrigated. In southern Ukraine, clean fallow is frequently omitted and a crop rotation will likely include sugar beets and/or sunflower, the region's chief industrial crops. A typical seven-year rotation might be: winter wheat, winter barley, sugar beets, winter wheat, winter barley, sunflowers, and corn. The summary is that a corn-soybean rotation is not as prevalent as some other legume-grass rotations (see *Country Summaries, FAO, 2007*).

India

Below are typical crop rotation strategies for a rice production area where pulse (legumes, including soybeans) would be used in rotation (see *Country Summaries, FAO, 2007*). This project was conducted using satellite mapping. The table highlights the different crop rotation options and quantifies the percentage of land area devoted to each option.

Table 1: Statistics of different Crop rotation classes derived using SPOT VGT data (2001-02)

Sl N o.	Crop Rotation Classes (Kharif-Rabi-Summer)	% of Net-Sown Area
1	Rice-Fallow	55.59
2	Upland crops-Fallow	25.15
3	Rice-Pulse-Fallow	10.88
4	Rice-Fallow-Pulse	3.66
5	Rice-Fallow-Rice	2.84
6	Fallow-pulse-Fallow	0.95
7	Fallow-Rice	0.45

China

Table 2: The Use of Soybean in Crop Rotation Practices in Different Regions of China.

Region	Crop Rotation Strategy	Remarks
Northeast China	Soybean-corn-broom corn-corn Soybean-broomcorn (rice)-corn Spring soybean-spring wheat	One crop per year
Valley of the Yellow and Huaihe Rivers	Winter wheat-summer soybean Winter wheat-summer soybean-corn Winter wheat-summer soybean-no crop winter-cotton	One crop per year or three crops in two years
Valley of the Yangtze River	Winter wheat – summer soybeans-winter wheat-corn Winter wheat-summer soybeans-	Two to three crops per year

	winter corn-cotton Winter wheat-summer soybeans-winter wheat-rice Winter wheat-summer soybeans and corn-winter wheat-sweet potato	
Southeast China	Early rice-autumn soybeans-winter wheat or corn Early rice-autumn soybeans-green manure or fallow in winter-late rice-winter wheat or corn	Water supply is low in autumn. Soybeans are frequently sown after the rice harvest

Source: *Zhang Mengheng, 1999. Problems and Solutions on Cultivation of Soybeans. China Braille Press, Beijing, China.*

As a result, it can also be noted that legumes are not always planted in an alternating rotation with grass crops. There are some farming systems where a farmer may plant two subsequent grass crops before planting a legume. The urea offset effect will equally occur in this case, i.e. urea application will be reduced to zero for the legume planting and urea application to the subsequent grass crop will be reduced. If a second grass crop follows the first, no further urea offset might take place. But as the methodology accounts for any urea used in the project activity, the baseline and project emission calculation procedures as defined in the methodology could equally be applied to such situation and would still result in a correct calculation of the greenhouse gas emissions.

Soybeans are a legume. Legumes are plants of the pea or bean family, Leguminosae. Legumes are able to fix atmospheric nitrogen, a process called biological nitrogen fixation, that provides nitrogen to the growing plant. Legumes are able to do this because of a symbiotic relationship with certain bacteria called rhizobia. The ability to form this symbiosis reduces the need for synthetic fertilizer, reducing the production of CO_2 that results from the production of synthetic fertilizers. Leguminosae is one of the largest families of flowering plants with 18,000 species classified into around 650 genera (see *Polhil and Raven, 1981*) or approximately one twelfth of all known flowering plants around the worlds. They range from dwarf herbs of arctic and alpine vegetation to massive trees of tropical forests. These legumes are used as crops, forages and green manures all over the world depending on the climate, soil structure, soil pH and farming systems (see *Farming Systems and Poverty, 2008, FAO*). As the table below shows, there are many forms of legumes and each legume has a specific rhizobium bacteria that it uses to fix nitrogen.

Rhizobium Classification	***Legume Group***	***Legume Type***
Rhizobium leguminosarum	Pea group	Pisum, Vicia, Lens
Rhizobium phaseaoli	Bean group	Phaseolus
Rhizobium trifolii	Cover group	Trifolium
Rhizobium meliloti	Alfalfa group	Melilotus, Medicago, Trigone
Rhizobium lupine	Lupini group	Lupinis, Orinthopus
Rhizobium japonicum	Soybean group	Glycine
Rhizobium sp.	Cowpea group	Vigna, Arachis

Source: www.migrobiologyprocedure.com/rhizobium-and-legume-root-nodulation/rhizobium-classification.html

The conclusion is that the claim of the methodology to use rhizobium bacteria as an inoculant to stimulate biological nitrogen fixation and to displace synthetic urea, regardless of the legume planted, would not change.

Corn is a member of the Poaceae or Gramineae family of plants. Plants of this family are commonly called grasses of which there are about 600 genera and between 9,000 – 10,000 species (*see Kew Index of World Grass Species*). The Paoceae (or Gramineae) plants are one of the most important of all plant families for human economies and include food grains (commonly known as cereals), lawn grasess, forages and bamboo, widely used for construction throughout east Asia and sub-Saharan Africa. A key characteristic of grasses, unlike legumes, it that they are not capable of fixing their own nitrogen for

growth. Therefore, they must have an exogenous source of nitrogen, either from carryover nitrogen from a previous legume crop, from organic nitrogen such as animal or human waste, or synthetic fertilizer. (It should be noted that the carryover nitrogen from a legume crop is usable by the following grass crop regardless of the legume that produced it or the grass crop utilizing it.) These grasses, used in rotation, should not be limited to corn, as is stated in the current methodology, as corn is not always adapted to the environment or another grass is needed in the farming system. Other grass crops used in rotation with legumes are barley, maize (corn), oats, rice, rye, sorghum, wheat, millet, bamboo, rye grass, sugarcane, and fescue, to name a few. Therefore, depending on the many diverse faming systems found in the world (see *Farming Systems and Poverty, 2008, FAO*), the revision of the methodology to include other grass crops would broaden its applicability on a global basis.

Thus, the authors request to broaden the applicability of the methodology to any legume-grass crop rotation, making it more appropriate for regional faming practices and expanding its capacity for CDM potential.

Ad (2) Extension of the applicability to synthetic fertilizers containing nitrogen other than urea

Urea is a type of N-fertilizer (synthetic nitrogen fertilizer) that is commonly applied on agricultural lands in developing countries. At the same time also other types of N-fertilizers are applied in developing countries. Hence, we think that it makes sense to broaden the applicability of the present methodology to also include application of N-fertilizers other than urea as well as fertilizers that include nitrogen besides other plant nutrients (K and P).

In the present methodology the CO_2 emission factor in the methodology rightly depends on the type N-fertilizer as the sources of GHG emissions from N-fertilizer production vary significantly across types and technologies of N-fertilizer production. Nitrogen is supplied in N-fertilizers as ammonium (NH_3 or NH_4+), amine (NH_2 - in urea), or as nitrate (NO_3-). All three forms of nitrogen require ammonia as a feedstock (see *Kongshaug, G. 1998. Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. IFA Technical Conference, Marrakech, Morocco, 28 September-1 October, 1998)*. As the CO_2 emissions associated with ammonia production are significant and widely researched, we in the following provide a suggestion for inclusion of all synthetic fertilizer types in the methodology irrespective of whether they are N-fertilizers or other synthetic fertilizers that include N.

The following table provides an exemplary list of the N-fertilizer types requested to be included in the methodology. The table also provides an exemplary conservative calculation of the emission factor (t CO_2/ t N-fertilizer) based only on the ammonia (NH_3) content of the N-fertilizer.

N-fertilizer types	N content (% of mass) **1)**	NH3 content (% of mass) **2)**	Emission factor t CO_2/t NH3 **3)**	Emission factor t CO_2/t N-fertilizer **4)**
Single nutrient products N-fertilizer				
Anhydrous Ammonia (NH3) "Ammonia"	82	67.2	2.104	1.415
Ammonium Sulfate [(NH4)2SO4]	21	17.2	2.104	0.362
Monoammonium Phosphate (MAP)	11	9.0	2.104	0.190
Diammonium Phosphate (DAP)	18	14.8	2.104	0.311
Ammonium Nitrate (NH4NO3)	33.5	27.5	2.104	0.578
Calcium Ammonium Nitrate (CAN)	26	21.3	2.104	0.449
Any other synthetic fertilizer containing N (e.g. multi nutrient fertilizers (N-P-K))	**X)**	**X)**	**X)**	**X)**

X) depending on fertilizer type

Sources:

- see *IDFC 1999: A Guide to Fertilizer Products for Traders*; see *Kongshaug, G. 1998. Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. IFA Technical Conference, Marrakech, Morocco, 28 September-1 October, 1998*
- calculated based on molecular weight ratio of 0.82 N/NH_3; see *Kongshaug, G. 1998. Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production. IFA Technical Conference, Marrakech, Morocco, 28 September-1 October, 1998*
- conservative European average value of natural gas based ammonia production; see *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3: Industrial Processes and Product Use; Chapter 3.2 Ammonia Production*
- calculated based on 2) and 3)

The CO_2 emission factor of N-fertilizer production in the above table has been calculated based on the standard NH_3 content in the specific type of single nutrient N-fertilizer used as well as a conservative CO_2 emission factor for ammonia production in developing countries.

Based on this approach it is also possible to calculate the emission factor t CO_2/t fertilizer for any type of synthetic fertilizers as long as the mass ratio of N in the fertilizer is known using the following formula:

$$EF_{CO2,f} = Ncont_f * 0.82 * 2.014 tCO_2 / tNH_3$$

Where:

EF(CO_2,f) is the emission factor for the production of fertilizer f (tCO2/tonnes fertilizer f)

Ncont(f) is the N content of fertilizer f on a mass ratio basis

0.82 is the mass ratio between N and NH_3

2.014 is a conservative emission factor for ammonia production in t CO_2/t NH_3

Hence, the authors request to broaden the applicability of the methodology to (a) the above list of single nutrient N-fertilizers for which in the absence of reliable project specific data the above listed conservative CO_2 emission factors may be used (b) any synthetic fertilizer (for which the mass ration of N in the fertilizer is known) for which in the absence of reliable project specific data the CO_2 emission factors may be calculated based on the conservative approach described above.

Recommendation by the SSC WG:
Please use the space below to provide amendments/change (in your expert view, if necessary).

Please refer to paragraph 9 of the meeting report of the SSC WG 19 (http://cdm.unfccc.int/Panels/ssc_wg).

Answer to authors of query by the SSC WG:
Please use the space below to provide answer to the authors of the above query

The small-scale working group of the CDM Executive Board would like to thank the author for the submission.

The expansion of the applicability of the methodology to include the described situation might be accepted, in case the following issues are addressed by the query author:

1. Extension of applicability to any legume – grass rotation:

a) It shall be demonstrated that there are technologies available to produce inoculants specific to a type of legume. As mentioned by the author of the submissions, there is a very large number of

leguminosae plants (a number of 18,000 species is mentioned), and each legume has a specific rhizobium bacteria that it uses to fix nitrogen. In case it is shown that there are technological procedures to produce inoculants to all kind of legumes, the proposal can be accepted. If, on the other side, there are technologies available for inoculants production able to be used only with a certain and limited number of legumes used in commercial plantations, the expansion of the applicability of the methodology shall be accepted only to these legumes. The proposal shall therefore be substantiated with technical information on the availability of inoculants. The technology to produce different rhizobia bacteria inoculants shall also be conducive to monitoring procedures that require counting the number of bacteria produced, as necessary in the determination of the emission factor described in paragraph 14 of the AMS.

b) It should be demonstrated that the procedure to monitor the inoculated plants, as described in Annex 1 of AMS-III.A, is valid and may be used with any kind of legumes. The monitoring of the effective growth of the inoculated rhizobia bacteria by means of the appearance of the nodules (based on their sizes and colour aspects) is necessary to the monitoring. This procedure is well known for soybeans. The author of the submission shall substantiate, with technical information and literature, that the same procedure can be used to any kind of legumes, when inoculated with the respective artificially grown rhizobia inoculants.

The SSC WG is of the view that if there are technologies for inoculants production and procedures to monitor its efficacy available to only a certain number of legumes used in commercial plantations, the expansion of the category shall be accepted only to those cases. These legumes shall be explicitly mentioned in the revised category, as well as the relevant technical literature.

2. Extension of the applicability to synthetic fertilizers containing nitrogen other than urea:

This extension may be incorporated into the category, as long as the fertilizers containing nitrogen other than urea will be used in reduced amounts in the project as compared to the baseline scenario. The emission factor based in ammonia content of the fertilizer as proposed in the amended Annex 2 is acceptable. Nevertheless, guidance shall be given on how to address the situation where a fertilizer containing nitrogen is replaced in the project scenario by other fertilizers, which do not contain nitrogen, but other nutrients (e.g. P or K). It shall be included as an applicability condition that the fertilizers applied in the project scenario shall not add more non-nitrogen nutrients to the plantation than the baseline. For instance, the total amount of phosphorous or potassium incorporated in the cropland in the project scenario shall be the same as in the baseline. Also, in the case that the project results in less use of the baseline fertilizer, and less P or K is used in the project as in the baseline scenario, these emission reductions can not be claimed by the project activity. In other words, the inoculation with rhizobia results in reduced consumption of nitrogen fertilizers, and this is the only emission reduction to be claimed by the project activity, even in the case where there is an additional reduction in the amount of other nutrients (K, P, etc.) in the project scenario, compared to the baseline scenario.

Signature of SSC WG Chair ……………………………………………..
(Hugh Sealy)

Date: 27/02/2009

Signature of SSC WG Vice-Chair ……………………………………………..
(Peer Stiansen)

Date: 27/02/2009

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