B-16.10 The Study of CH_4 and N_2O Emissions Management on Grassland

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Abstract So far, we measured methane (CH_4) and nitrous oxide (N_2O) fluxes at the grassland in 91, 95, 96, 97, in 98. Moreover, it measured CH_4 and N_2O fluxes at the slurry applications with several times. And, it got these gas fluxes data by Upland Field Management Laboratory of Kyushu National Agricultural Experiment Station and Soil Science Section of Hokkaido Prefectural Konsen Agricultural Experiment Station. Based on these data, we made the emission factor index for CH_4 and N_2O from grassland and animal waste. This emission factor index is the revise of the index that was made in 94(B-2.4.2 Emission of Trace Gases Contributing Greenhouse Effect from Grassland by GERF). Besides, we made the emission factor indexes of slurry application methods and nitrogen fertilizers.

We have proposing the management that N_2O emission could be effectively reduced by the change in the kind with nitrogen fertilizer, and degraded CH_4, N_2O emissions at slurry application on field by the mixing and aeration method before slurry store (B-16.3 Studies of Control and Activities of Greenhouse Trace Gases in Grassland by GERF). The our proposing N_2O emission decreasing method after fertilizer application made fertilizer cost up about 17-51%, compared with conventional fertilizer application. And so, the mixing and aeration before slurry store showed that it cost about 2,000,000 yen as an annual cost in the way of disposing of it.

Furthermore, we did impact assessment to effect on greenhouse effect in the grassland animal husbandry system by using the index which influenced grass area and which was revised, CH_4, N_2O emissions inventory of domestic grassland in Japan, Global Warming Potential (GWP). The result, it was shown that nitrogenous fertilizer, animal excreta (slurry) had large impact for greenhouse effect, and it thought that these were to become the objects of the measurement and research that it was necessary for intensively.

Key Words Grassland, Nitrous oxide, Methane, Animal waste, Nitrogen fertilizer

1. Introduction

In November 97, The 3rd Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCC/COP3) was held in Kyoto, Japan. That the reduction objects added Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6) in the conference was decided with Carbon dioxide (CO_2). The reduction goal of these gases does 5 (2008-2012) years with the goal period and it sets them to it. To make the action plan to have paid to this reduction goal achievement, the estimation of high precision of these gases emissions and sinks is demanded.

The greenhouse gases that occurs much in the grassland animal husbandry system is CH_4 and N_2O. As for the sources of these gases, the CH_4 and N_2O emissions from animal waste and N_2O emission from the nitrogen fertilizer is high. Therefore, to restrain the emissions of these gases from these parts is important.

2. Research Objective

And then, based on the accumulating data, we planned to revise in CH_4, N_2O emission factor index at grassland that was experimentally made in 94. Besides, it made emission factor indexes every kind with slurry applications and nitrogen fertilizers. Also, it investigated about the cost of the effective way of the fertilization management to restrain N_2O emission and degraded CH_4 and N_2O emissions at slurry application on field by the stirring and aeration method before slurry store. Furthermore, we did impact assessment to effect on greenhouse effect in the grassland animal husbandry system.

3. Research Method

(1) The revision of the emission factor index relating to grassland and animal waste

At the grassland, it measured the CH_4, N_2O gas fluxes in 91, 95, 96, 97 in 98. Also, it measured several times, CH_4, N_2O gas fluxes at the time of slurry application. And, it got these gas fluxes data by Upland Field Management Laboratory of Kyushu National Agricultural Experiment Station and Soil Science Section of Hokkaido Prefectural Konsen Agricultural Experiment Station. Based on their data, it examined the revision of the emission factor index in 94 (B-2.4.2 Emission of Trace Gases Contributing Greenhouse Effect from Grassland by GERF).

(2) The planning of the emission factor index according to the kind with slurry application ways and nitrogen fertilizers

As for the reduction technique of CH_4, N_2O emissions to have examined so far (B-2.4.2 Emission of Trace Gases Contributing Greenhouse Effect from Grassland, B-16.3 Studies of Control and Activities of Greenhouse Trace Gases in Grassland by GERF), it examined the planning of emission factor index about the kind with slurry application ways and nitrogen fertilizers.

(3) The cost investigation of the reduction countermeasure which is effective in CH_4, N_2O emissions in the grassland animal husbandry system.

We did cost investigation for the mixing and aeration method before slurry stored for decreased CH_4, N_2O emissions at slurry application on field, fertilizing management that is effective in N2O emission decreased after fertilizer application. These planned to do in 97(B-16.3 Studies of Control and Activities of Greenhouse Trace Gases in Grassland by GERF).

(4) The clarification of the objects which is necessary of intensive measurement and research and the impact assessment on a greenhouse effect of the grassland animal husbandry system.

CH_4, using the revised index of grassland made N_2O emission inventories. The Global Warming Potential (GWP) was used for the environment load influence assessment, and it went through the one with the weight of the related objects, and evaluated.

4. Results and Discussion

(1) The revision of the emission factor index relating to grassland and animal waste

In the index that was made in 94, it showed emission factor in addition to the examination in the standard error. After that, there are some factors with increased measurement experiments. Therefore, we examined to revise emission factor added gas flux data by statistic processing.

The emission factor that was shown here was gotten in Nasu area, Tochigi, Japan where is National Grassland Research Institute. Therefore, to apply to all Japan, it is necessary to examine. To settle on the emission factor that corresponded to all Japan, the investigation inside Hokkaido that has about 80 % of grassland in Japan and in Kyushu area that is doing much animal waste application is necessary.

And then, it got these gas fluxes data by Upland Field Management Laboratory of Kyushu National Agricultural Experiment Station (after called Miyakonojo) and Soil Science Section of Hokkaido Prefectural Konsen Agricultural Experiment Station (after called Konsen).

Table 1. N_2O-N emission rate of each place (Nishinasuno data is calculated between 91～98 data).

	N_2O-N emission rate of cattle slurry	N_2O-N emission rate of nitrogen fertilizer
Konsen	0.16, 0.33 N_2O-N%/T-N	0.25, 0.25 N_2O-N%/applid N amount
Miyakonojo	0.35 N_2O-N%/T-N (average)	— — —
Nishinasuno	0.12 N_2O-N%/T-N (average)	1.0 N_2O-N%/applid N amount (average)

Because an examination about CH_4 wasn't done at Miyakonojo, Konsen, the data (Table 1) provided by both sites were only N_2O data about slurry and the nitrogen fertilizer. It particularly tries to go though simple comparison can't be done, because the examination condition of these data is different. When N_2O-N emission factor of slurry was compared, the data of Konsen which was low about 7℃ (average temperature compared with Nishinasuno) was more expensive than observed data at Nishinasuno(in average, about two times, n=2). On the other hand, as for Miyakonojo as well whose average temperature was higher than Nishinasuno by about 4℃, N_2O-N emission factor of slurry at Miyakonojo was shown higher value (in average, about three times, n=6) than Nishinasuno. Also, N_2O-N emission factor of nitrogen fertilizer was compared with Nishinasuno (This data is only Konsen). The data observed in Konsen was within the range of the observed data in Nishinasuno (0.1~4.4 N_2O-N %/applied N amount), and it was about 1/4 (n=2) in average. The fulfillment of the future measurement example is necessary, because there are few measurement examples to examine these causes.

Based on their data, it examined the revision of the emission factor index in 94.

Table 2. The emission factor index relating to grassland and animal waste

N_2O emission factor	n	median	average	standard deviation	range	Unit
Grassland	5	44.0	43.8	2.5	40.6-47.4	N_2O-N mg / m^2 / yr
Nitrogen fertilizer	22	2.3	0.9	0.9	0.1-4.4	N_2O-N%/appliedNamount
Feces of grazing cattle*1	7	0.07	0.05	0.04	0.02-0.11	N_2O-N % / T-N
Urine of grazing cattle	7	0.37	0.27	0.18	0.12-0.61	N_2O-N % / T-N
Cow slurry	12	0.21	0.16	0.11	0.06-0.35	N_2O-N % / T-N
Excreta of grazing cattle*2	--	0.32	--	--	0.09-0.55	N_2O-N g / cattle / day
Forest floor	1	--	45.9	--	--	N_2O-N mg / m^2 / yr
CH_4 emission factor	**n**	**median**	**average**	**standard deviation**	**range**	**Unit**
Grassland	5	-126.5	-129.9	18.8	-106.8- -146.2	CH_4-C mg / m^2 / yr
Feces of grazing cattle	7	0.19	0.18	0.06	0.10-0.28	CH_4-C % / T-C
Cow slurry	9	0.31	0.26	0.15	0.06-0.55	CH_4-C % / T-C
Excreta of grazing cattle*2	--	2.75	--	--	0.85-4.65	CH_4-C g / cattle / day
Forest floor	1	--	-449.5	--	--	CH_4-C mg /m^2 / yr

*1:In Early Spring and continuous drying condition after defecation, N_2O emission does not occur every time.

*2:This data is simulation output of grazing cattle growth model.(Preliminary Study of a Model Describing the Growth of Grazing Cattle. M. Tsuiki et al., Bull. Natl. Grassl. Res. Inst. 43,1-11(1990))

The revised emission factor index (Table 2) has higher precision about the part with the measurements times than before it. However, there is one that the median and the standard deviation leave to the average in the factor. By the application time and the treatments applied to field of fertilizer and animal waste, CH_4, N_2O emissions are gravely influenced. Because it wasn't arranging for those conditions strictly at experiments, it was never high precision factor value. Therefore, the measurement example must be more piled with the future. Especially, as for the factor that is related with animal waste, because there is little measurement number of times, to increase experiments is important.

(2) The planning of the emission factor index according to the kind with slurry application ways and nitrogen fertilizers

(2)-1 The making of the emission factor index of CH_4, N_2O relating to cow slurry

We aimed to reduce CH_4, N_2O emissions by changing the slurry application methods. And then, it gathered their emission factors to Table 3.

The examination of the degraded technique for CH_4, N_2O emissions at slurry application time was assumed in the use of the machine that often exists. Also, there were methods with little measurement times. As for these methods, it should increase the measurement times and improve precision more. After that, the effectiveness of the application techniques should be confirmed. The application methods, which was comparatively much examined in the past, were surface application and soil injection. When comparing these application methods, it finds that the trade-off relation occurs between the emissions of CH_4 and N_2O. And so, it added nitrification inhibitor immediately to slurry application. By doing that slurry for soil injection, it planed the degraded CH_4, N_2O emissions. Here, nitrification inhibitor was using thio urea. When using the other nitrification inhibitor, N_2O emission changes. Therefore, it is necessary to examine about the other nitrification inhibitor.

Table 3. The emission factor index of CH_4, N_2O relating to cow slurry

N_2O emission factor	n	median	average	standard deviation	range	unit
Slurry						
Surface application	12	0.21	0.16	0.11	0.06-0.35	N_2O-N % / T-N
added N.I.*	1	--	0.07	--	--	//
Soil injection	6	0.51	0.45	0.18	0.29-0.72	//
added N.I.*	1	--	0.20	--	--	//
Soil mixed application	1	--	0.15	--	--	//
Tine injection	1	--	0.18	--	--	//
Slurry tank	1	--	4.27	--	--	N_2O-N g / cattle / yr

CH_4 emission factor	n	median	average	standard deviation	range	Unit
Slurry						
Surface application	9	0.31	0.26	0.15	0.06-0.55	CH_4-C % / T-C
Soil injection	6	0.06	0.07	0.03	0.02-0.10	//
Soil mixed application	1	--	0.09	--	--	//
Tine injection	1	--	0.18	--	--	//
Slurry tank	1	--	23.0	--	--	CH_4-C g / cattle / yr

*: N.I. is nitrification inhibitor. This case is thio urea, added 0.5 weight % Slurry T-N.

(2)-2. The making of the emission factor index of N_2O relating to nitrogen fertilizers

To apply nitrogen fertilizer at grassland, N_2O occurs at the time. Therefore, it did the examination to make N_2O emission reduce in changing nitrogen fertilizer. Every characteristic thing of nitrogen fertilizers to have used this time was shown in Table 4.

Table 4. The character of experimental nitrogen fertilizers

Fertilizer	Call name	Character
High analysis mixed fertilizer	17ALL	$N-P_2O_5-K_2O$=17-17-17% T-N ratio is NH_4-N: 47% and urea-N: 53%
Slow-N release fertilizer		
Chemical synthesized type	CDU	CDU-Urea
Coated urea(fast type)	LP30	30 days in solution
Coated urea(slow type)	LP70	70 days in solution
Coated calcium nitrate	Long40	40 days in solution
Added nitrification inhibitor		
added DCD	DCD	$N-P_2O_5-K_2O$=15-15-15% Added nitrification inhibitor is dicyandiamide.
added AM	AM	$N-P_2O_5-K_2O$=15-15-15% Added nitrification inhibitor is 2-amino-4-chloro-6-methylpirimidine.
Calcium nitrate	Ca-N	High deliquescence

In each fertilizer experiments, superphosphate was used as P_2O_5 and potassium chloride was used as K_2O, except for 17ALL, DCD, AM.

The fertilization at grassland applies nitrogen fertilizer on grassland surface. Because soil injection of fertilizer influences grass yield at grassland, it doesn't do generally. And then, the result, which applied examined nitrogen fertilizer to grassland surface, were shown in Table 5.

Table 5. The emission factor index of N_2O relating to nitrogen fertilizers

	n	median	average	standard deviation	range	unit
17ALL	20	2.3	1.0	0.9	0.1-4.4	N_2O-N % / applied N amount
CDU	12	0.5	0.4	0.3	0.0-1.0	〃
LP30	8	0.4	0.3	0.2	0.1-0.7	〃
LP70	12	0.3	0.2	0.2	0.0-0.6	〃
Long40	8	0.4	0.4	0.2	0.1-0.6	〃
DCD	12	0.4	0.3	0.2	0.0-0.8	〃
AM	12	0.4	0.4	0.2	0.1-0.7	〃
Ca-N	12	0.4	0.2	0.2	0.0-0.8	〃

Like Table 2, the any results of N_2O emissions of experimental nitrogen fertilizers have different average from median and standard deviation. Because it wasn't arranging for those conditions strictly at experiments, it was never high precision factor value. Thus, the measurement example must be more piled with the future. Therefore, it is difficult to build N_2O emission management plan only at the emission factor index that is shown here. The examination which included application time, area and yield, is necessary to N_2O emission management plan.

(3) The cost investigation of the reduction countermeasure which is effective in CH_4, N_2O emissions in the grassland animal husbandry system.

(3)-1 The cost investigation about N_2O degradation from grassland by change of the applied nitrogen fertilizer

We planned effective fertilization in N_2O discharge depression in question with a little in procurement and easiness of handling, yield and calculated the diminution factor as a test (Table 6), in 97(B-16.3 Studies of Control and Activities of Greenhouse Trace Gases in Grassland by GERF). And then, as for this fertilization management, we did cost investigation.

Table 6. Fertilizer application management for N_2O emission to degrade

Fertilizer application management	Rate of N_2O emission to degrade
All fertilizer application time, use of chemical fertilizer added nitrification inhibiter (DCD, AM)	43～57%
All fertilizer application time, use of slow-N release fertilizer (CDU), except for spring time, by high analysis mixed fertilizer (17ALL)	47%

Every fertilizer application time for grassland, N-P_2O_5-K_2O=5-5-5kg/10a

As a result, the fertilizer cost increased by about 17-51% compared with the case to have used conventional practice fertilizer as shown in Table 7. The way of cost's becoming the highest was the plan that used CDU.

Because it is aimed that these custom method is put simple and easy a change with the principal objective, we did not changed NPK amounts of fertilizer in every fertilization. Generally, slow-release fertilizer is high fertilizer efficiency. Therefore, it is possible for the application rate of fertilizer to decrease by using slow-release fertilizer. If it is possible for the application rate of fertilizer to decrease, the fertilizer cost and N_2O emission are degraded. Then, the use of slow-release fertilizer will become effective option.

The cost and to decrease application rate of fertilizer are necessary the examination.

Table 7.The cost investigation about N_2O degradation from grassland by change of the applied nitrogen fertilizer

	Annual cost per 10a	The difference between conventional and N_2O degradation plan
All splits application of fertilizer by 17ALL (conventional practice fertilizer)	¥10,588	--
All splits application of fertilizer by AM	¥14,452	¥3,864
All splits application of fertilizer by DCD	¥12,388	¥1,800
Early spring splits ·application of fertilizer by17ALL, and other times by CDU	¥15,993	¥5,405

Every fertilizer application time for grassland, N-P_2O_5-K_2O=5-5-5kg/10a

CDU application cost include with superphosphate and potassium chloride cost. Fertilizer costs calculate at December, 98.

(3)-2 The cost investigation about the mixing and aeration treatment method for decreased CH_4, N_2O emissions on cattle slurry field application

Cost investigation was done about the method (Table 8, Figure) which reduced CH_4, N_2O emissions at slurry application by doing mixing and aeration treatment before slurry stored, which showed in 97.

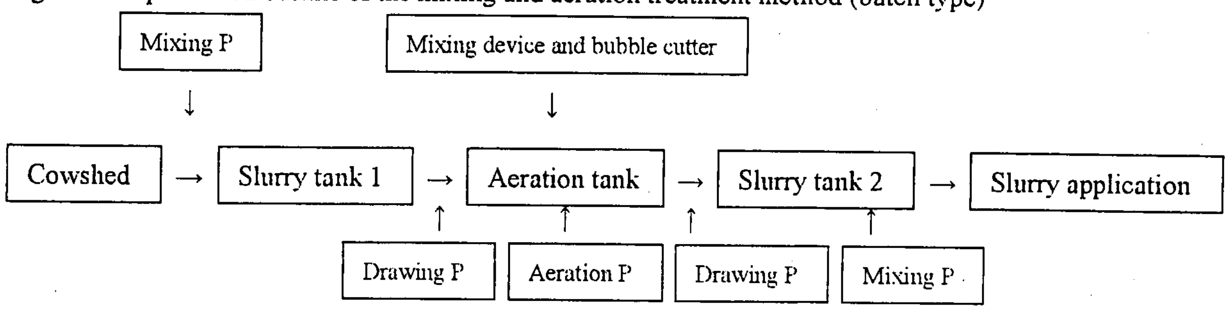
Table 8. The anticipated CH_4, N_2O degraded emission rate by the mixing and aeration treatment*

	mixing and aeration time + stored time emission	emission at field application
degraded CH_4 emission rate	83%	90%
degraded N_2O emission rate	---	50%

*: The following supposition is put, before the trial calculation.

The mixing ad aeration treatment is done for 15 days before the slurry stored. After that, it store for 162 days, and the slurry is done surface application on field. The mixing and aeration treatment method is choice the mixing by submergible pump and aeration treatment or the mixing by impeller and aeration treatment.

Figure. The presumed outline of the mixing and aeration treatment method (batch type)



*: All P (pump) are supposed powered by electricity.

It makes the trial calculation of the cost about the method shown in Table 8 and Figure, and it is shown in Table 9. It is supposed that scrap value is 0 yen, and that the useful life of the mixing and aeration devices and slurry tanks are 5 years, 20years, respectively. And then, we can calculate by the uniform charge method that the annual cost is about 2,000,000. But, because there are many preconditions, there is a factor that a cost swells further.

And, emission of the bad smell materials such as ammonia happens in mixing and aeration. Therefore, the cost swells further if a deodorization device is installed. However, the cost decreased is thought to be possible by the use for the existent devices and the examination such as an operation condition.

Though it isn't examined here, the continuous treatment form of mixing and aeration for cattle slurry and other cattle slurry treatment such as compost treatment should be examined for the decreased CH_4, N_2O emissions and the treatment cost.

Table 9 The cost for cattle slurry mixing and aeration treatment devices.

	Acquisition cost	Annual cost
Case 1: There is one slurry store. It is supposed to choice the mixing by impeller and aeration treatment method.	¥19,264,000	¥1,916,300
Case 2: There is one slurry store. It is supposed to choice the mixing by submergible pump and aeration treatment.	¥20,529,000	¥2,169,300
Case 3: New construction. It is supposed to introduce the system of the A company which devices composition is about the same case 1 or case 2.	¥27,930,000	¥2,686,500

Contents: Case 1	○mixing and aeration treatment devices sum cost : ¥6,354,000
	・mixer : 7.5kw ¥730,000
	・aeration pump : 3.75kw ¥644,000
	・bubble cutter : 0.75kw×2 ¥340,000
	・drawing pump : 4.0kw×2 ¥2,060,000
	・mixing pump : 3.75kw×2 ¥2,580,000
	○slurry tanks sum cost : ¥12,910,000
	・aeration tank (126m^3) ¥5,160,000
	・slurry stored tank (388m^3) ¥7,750,000
Contents : Case 2	○mixing and aeration treatment devices sum cost : ¥7,619,000
	・submergible pump : 15kw ¥1,995,000
	・aeration pump, bubble cutter, dawning pump, mixing pump are the same Case 1.
	○slurry tanks sum cost : the same Case 1.
Contents : Case 3	○mixing and aeration treatment devices sum cost : ¥8,600,000
	○slurry tanks sum cost : ¥19,330,000
	・pre slurry stored tank (239m^3) ¥6,420,000
	・aeration tank (126m^3) ¥5,160,000
	・slurry stored tank (388m^3) ¥7,750,000

It is supposed 60 head scales in all the cases. Construction expenses aren't contained. (case 1,2). Because it changes under the site conditions, the foundation works for the devices establishment and the site fee aren't contained. Though each tank capacity is a little over scale, closer tank to the assumption capacity in the reference materials is chosen. And, all tanks are supposed the ground establishment type. Because the underground establishment type is estimated by site condition, the tank price can't be decided. Because the practical scale trial isn't done, it doesn't have decided the operation condition. And then, the calculation of the use electric power rate isn't done. As for the life years, slurry tank and mixing and aeration devices are 20 years, 5yeras, respectively. Annual cost is calculated by the uniform charge method. And it doesn't think any scrap value at the useful life filled.

(4) The clarification of the objects that is necessary of intensive measurement and research and the impact assessment on a greenhouse effect of the grassland animal husbandry system.

The CH_4, N_2O emissions inventories of Japan were made by using the index of (1). (Table 10).

We did trial calculation of the environmental load related to greenhouse effect (Table 11). It was done the emissions of Table 10 multiply by GWP (Global Warming Potential). And, we showed the environmental load related to greenhouse effect that tried the degraded methods for CH_4, N_2O at fertilizer application and slurry application.

Table 11 is showed, there are large impacts for greenhouse effect that have been nitrogen fertilizer and slurry application.

In other words, it considers that it is effective to make counter method about the nitrogen fertilizer and cattle slurry to reduce CH_4, N_2O emissions from grassland.

Table 10 Estimation of CH_4 and N_2O emissions in Japan

			Emission factor		Size	Emission (Gg/yr)
Grassland (except pasture)	Grassland	N_2O	43.8×10^4	N_2O-Nmg/ha/yr	344×10^3ha	0.2
		CH_4	-129.9×10^4	CH_4-Cmg/ha/yr	〃	-0.4
	N fertilization	N_2O	$0.9/100\times250$	N_2O-Nkg/ha/yr	〃	0.8
Pasture	Grassland	N_2O	43.8×10^4	N_2O-Nmg/ha/yr	375×10^3ha	0.2
		CH_4	-129.9×10^4	CH_4-Cmg/ha/yr	〃	-0.5
	N fertilization	N_2O	$0.9/100\times54$	N_2O-Nkg/ha/yr	〃	0.2
Grazing cattle	excreta	N_2O	0.32	N_2O-Ng/head/day	220×10^3head $\times$ 191days	0.01
		CH_4	2.75	CH_4-Cg/head/day	〃	0.1
Slurry application	Grassland	N_2O	$0.16/100\times0.37/100\times60\times2$	N_2O-Nkg/ha/yr	344×10^3ha	0.2
		CH_4	$0.26/100\times3.63/100\times60\times2$	CH_4-Ckg/ha/yr	〃	3.9
	Forage field	N_2O	$0.16/100\times0.37/100\times60\times2$	N_2O-Nkg/ha/yr	174×10^3ha	0.1
		CH_4	$0.26/100\times3.63/100\times60\times2$	CH_4-Ckg/ha/yr	〃	2.0

And then, we decided the size of CH_4 and N_2O source related grassland from the statistics by Division of Animal Industry, MAFF, Japan ; Area of grassland (except pasture) :344×10^3 ha, Area of pasture : 375×10^3 ha=305×10^3 ha + 70×10^3 ha (natural pasture), Number of grazing cattle : 220×10^3 (cow : 126×10^3, meat : 94×10^3).

Then, We supposed the following ; Applied N fertilizer amount is Grassland(except pasture) : 250kg-N/ha/yr, Pasture : 54kg-N/ha/yr, Natural pasture : no fertilizer application. The grazing span on pasture is from April to December, 191days. Applied cattle slurry amount is 6t/10a, $\times2$, per year.

Table 11 The assessment of environmental load related to greenhouse effect

Item			load	Subtotal	load at improvement	Subtotal
Grassland (except pasture)	grassland	N_2O	97	477	97	321
		CH_4	-11		-11	
	N fertilization	N_2O	390		234	
Pasture	grassland	N_2O	97	182	97	143
		CH_4	-13		-13	
	N fertilization	N_2O	97		58	
Grazing cattle	excreta	N_2O	5	8	--	--
		CH_4	3		--	
Slurry application	grassland	N_2O	97	301	49	89
		CH_4	102		10	
	forage field	N_2O	49		24	
		CH_4	53		5	

GWP (IPCC ,2 nd assessment) CO_2:1, CH_4:21, N_2O:310

We supposed that the degraded N_2O emission rate in improvement fertilizer application: 40%, the degraded CH_4, N_2O emission rates at slurry field application by slurry mixing and aeration method: 90%, 50%, respectively.

On the other hand, the present condition of the Japanese stock farming is in conditions that many amount of animal excreta have to use effectively in grassland and the feed field. Therefore, the application amount of cattle slurry is reduced simply, and the means that CH_4, N_2O emissions are reduced can't be adopted. And then, the effective use of the animal excreta becomes a premise. Then, the counter method for CH_4. N_2O emissions to reduce must do considered the yield and quality of feed crop and grass as well as cost.

And, as for the Table 11, the load isn't being added, because the measurement of greenhouse effect gas load that occurs with the acceptance of the decrease plan is insufficient. Therefore, because it is expected to increase further the actual load, the further correct load becomes a future examination subject.

Now, as for the size of activities that is necessary for the trial calculation, because there are many unclear parts of the actual condition, supposition is put, and it makes a trial calculation. So, it hopes for the fulfillment of the statistics investigation about the value about the size of activities and the improvement of reliability.