4. Construction of integrated platform and common information system for promoting the research project.（Abstract of the Final Report）

Contact person Koichi Yamada
Faculty of Science and Technology
Seikei University, 3-1 Kichijoji-kitamachi 3-chome,
Musashino-shi, Tokyo 180-8633, JAPAN
Tel: +81-422-37-3887 (direct) Fax.+81-422-37-3871
E-mail: yamada@st.seikei.ac.jp

Total Budget for FY2003-FY2007 75,662,000Yen (**FY2007**; 15,070,000Yen)

Key Words greenhouse-gas, sink/source control, terrestrial ecosystem, cost estimation, roadmap

I. Overview

In this project, three typical ecosystems are studied: 1) forestry, 2) tropical wet land, and 3) agricultural (i.e., cultivated, slash-and-burn, agricultural, and cattle lands). These three ecosystems have been expected to have high potential of global warming mitigation in the terrestrial ecosystem. Two themes (a, b) are identified for each ecosystem for GHG sink/source control technology development.

By research team 4, a common platform was constructed for sharing information among researchers in this area, by gathering essential information about GHG sink/source control technologies of the three ecosystems from six research teams (1a-3b). On the platform, GHG reduction potential, effect of a developed technology implementation on environments, its cost and scenario are included.

The project has been operated effectively by a spiral-up method as shown in following figure.

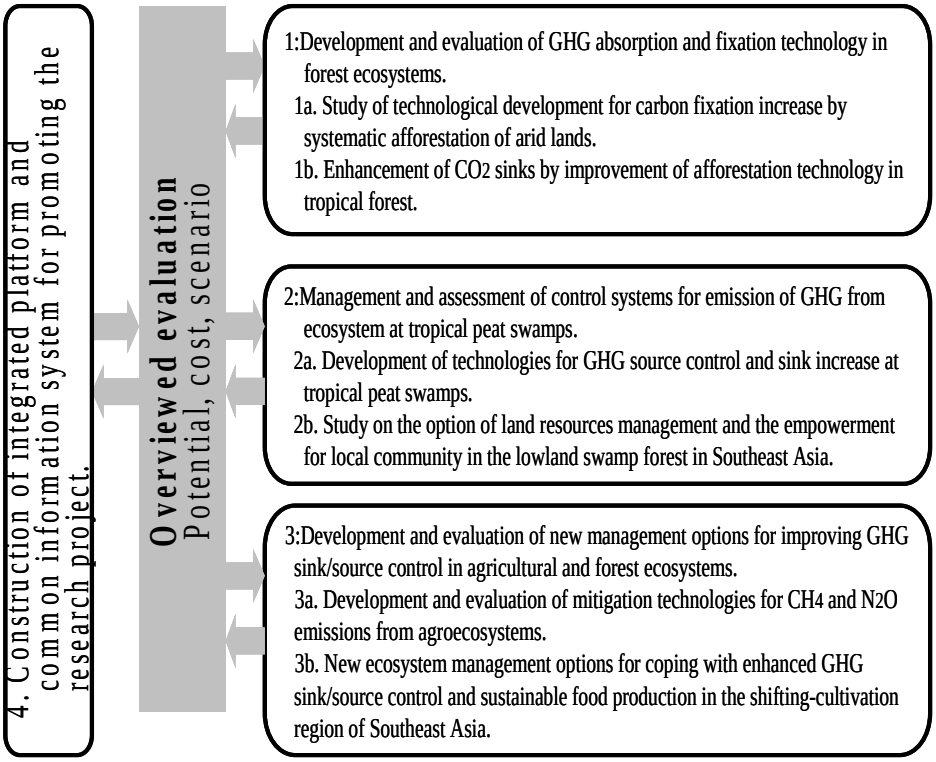
II. Scientific outcome

・The overviewed evaluation on GHG reduction potential, implementation cost and environmental impact in the objective and also global areas where the developed technology and knowledge obtained by this project was made in <Platform construction and information sharing for integrated promotion of the research project>

・Using the evaluation results, the total GHG reduction potential by the technology developed in this project was calculated to be more than 10BtC in 20 years.

・The highest potential in three ecosystems targeted by this project existed in South East Asia peat swamp and its value was 3.6BtC.

・The measures applicable to policy of environmental issues in a short time were clarified for each research team based on the evaluation result of cost, technology level and environmental impact. The selected measures from each research theme are,



1a) Afforestation in Western Australia arid land by a blasting method.

1b) Improvement of reforestation system in tropical forest applied to timber industry.

2a) Rewetting of developed peat swamp by planting trees.

2b) Improvement of paddy field in developed peat swamp.

3a) CH4 reduction by water management of Indonesia paddy field

Most of the C reduction costs of measures are below $100/tC of the project target values.

III. Contribution to policy of global environmental issues for decision makers

・The overviewed evaluation on GHG reduction potential, implementation cost and environmental impact in the objective and also global areas where the developed technology and knowledge obtained by this project was made in <Platform construction and information sharing for integrated promotion of the research project> Scenarios were designed based on the project results to contribute to policy of global environmental issues.

・By the cooperation between other teams, economical impact and environmental positioning of the technologies proposed by them became clear. Fundamental data on GHG source/sink control system, with a scientific background and environmental/economical evaluation, were gathered and organized for making recommendations for policy makers.

1. Introduction

Intermediate to long-term strategies for the stabilization of atmospheric greenhouse-gas (GHG) concentration are needed. New technologies to support the Japanese global environmental policy option should be developed, targeting the term after the Second Commitment Period of the Kyoto

Protocol. Among the possible technologies, GHG sink/source control through conservation and efficient management of terrestrial ecosystem is promising because of its large potential impact on GHG concentrations, low cost and high reliability and applicability before the establishment of soft energy systems that rely only on renewable energy resources. However the technical background needed to make such systems, such as basic technologies and scientific knowledge, is still insufficient. The promotion of the development of these technologies and the accumulation of scientific knowledge are needed, including assessment of the environmental effects of the use of such new technologies, some of which can be effective measures for CDM (Clean Development Mechanism) and JI(Joint implementations) in the near future.

2. Research Objective

The research objective is to develop GHG sink/source control technology in forestry, tropical wetland and agricultural ecosystems which are expected to have high potential of global warming mitigation in the terrestrial ecosystem.

Further, other objective is to clarify GHG reduction potential, impact of developed technology implementation on environments and its cost to contribute to environmental policy issues.

3. Research Method and Results

(1) The objective of this theme is to construct an integrated platform of GHG sink/source control through conservation and efficient management of terrestrial ecosystems to manage the project efficiently and to open the project results to the public.

Research theme of this project cover a wide range of field and need research and development of many basic know ledges and technologies.

It is important to clarify the state of the art and also future prospect of this project.

At first, a framework of basic technology evaluation was designed to clarify the development state of each research team.

The framework designed contains following items.

(A)The evaluation index is based on the GHG reduction amount.

(B)The evaluation results for each research theme are compared not only each other in the project, but also with those of measures proposed outside of the project.

(C)Relative difficulties and also uncertainties of the basic technology developments are clarified.

(D)The evaluation results are related to CDM and /or JI in UNFCCC.

(E)The construction of the framework should not require hard work for each research team.

(F)The propriety and validity of the framework are periodically checked and improved.

Through the framework construction, a GHG reduction potential of this project was estimated to be as high as 10GtC, as shown in table 1. Additionally, implementation scenario of the project result, a roadmap was made. The summary of the roadmap is shown in Fig.1.

Table 1 Summary of the overviewed evaluation on GHG reduction potential and environmental impact in the objective and also global areas

	1a		1b	2a
Theme	**Arid land afforestation**	**Afforestation for salt affected wheat field**	**Afforestation using fast growing tree**	**Reduction of GHG emission in wet peat land**
Scale km^2	**2,500(Experimental sites) 2,250,000 (Western Australia) 4,700,000 (global)**	**62,000 (Western Australia) 554,000 (global) (salt accumulated fields)**	**335,000(Indonesia) 884,000 (global) (tropic wet land)**	**320 (Thailand, Experimental site) 51,400 (Southeastern Asia, reclaimed peaty marsh)**
Potential *MtC	**700 (Western Australia) 1,800 (global)**	**4 (Western Australia) 40 (global)**	**19 (Indonesia) 50 (global)**	**3,600**
Comments	**● 30% of rainfall water gathered and used for tree-growth. Area with annual rainfall 200-300mm (1,120,000km^2)**	**● Fields with middle salinity damage, 5000km^2 (8% of crop field area), W.A. ● 554,000km^2 , global**	**● Implementing in 5% of lands for agricultural use (global 44,200 km^2)**	**● 1% of carbon stored in global tropical rainforest ● Prevent peat oxidation in reclaimed area ● Assuming 20% of peaty marsh is already reclaimed. ● Decomposition rate depends on land usage 18-68tC/(ha•y)**

*** Potential magnitude of GHG reduction/sequestration for 20 years.**

Table 1 (Continued)

	2b	3a		3b
Theme	**Management of wet land**	**Reduction of CH_4 from paddy field**	**Reduction of CH_4 from livestock**	**Improvement of slash-and-burn procedure**
Scale km^2	**500(Indonesia Experimental sites) 200,000 (Southeastern Asia, peaty marsh)**	**131,000,000 (global)**	**30,800,000 (Asia)**	**1,000,000 (over-cultivated slash-and-burn field)**
Potentia	**3,600**	**650(Reduction)**	**370(Reduction)**	**490**

l *MtC				
Comments	**● Prevent the degradation of the forest ● Assume 20% difference in forest area fractions with and without social empowerment ● Recovering of degraded paddy field, etc.**	**● Sustained reduction ● Estimated reduction amounts are around 3% of global CH_4 emission form paddy fields, and 1% of that from ruminant live stocks. ● Reduction of CH_4 and N_2O from other sources are also examined. ● Acquisition of data on agricultural GHG source was conducted. ● Evaluation and demonstration of other new technologies were also conducted.**		**● Slash-and-burn area in Southeastern Asia 2,000,000km^2 ● Assume 50% of the area is over-cultivated ● Based on estimated carbon stock of each stage in slash-and-burn cultivation**

*** Potential magnitude of GHG reduction/sequestration for 20 years.**

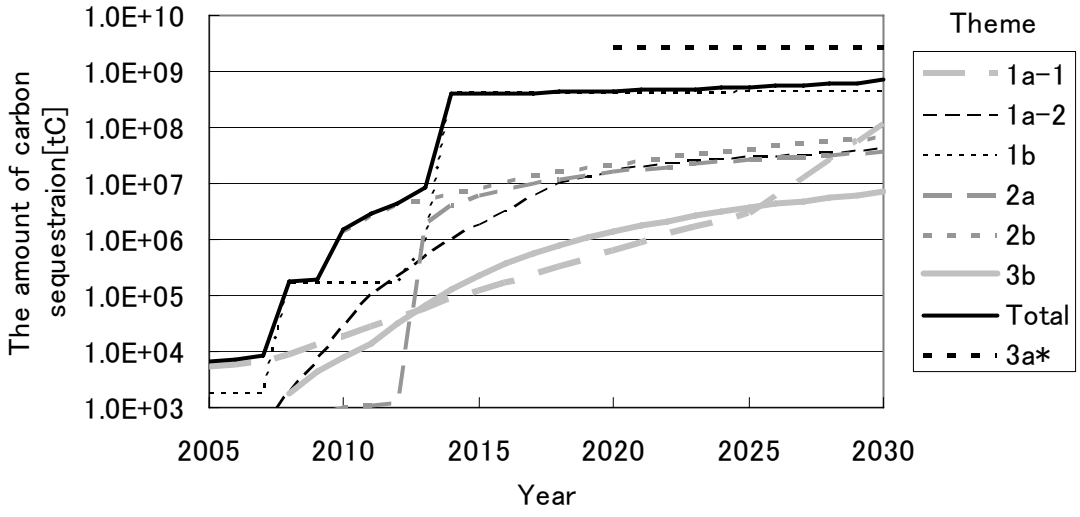


Fig.1 Summary of the accumulated amount of GHG sequestration/reduction in the road maps of each themes. For Theme 1a, 1a-1 and 1a-2 represents “Arid land afforestation” and “Afforestation for salt affected wheat field”, respectively. For theme 3a, total reduction potential of all sub themes is presented. Amounts of 20 years accumulated GHG are shown for continuous reductions.

(2) Cost estimations were performed for some measures proposed form other research teams, by gathering economic and environmental data. Evaluation of efficiencies was also attempted.

The following six subjects were selected.

1a : CO_2 fixation by both afforestation using blasting of hard pan and afforestation for preventing salt problem in Western Australia.

1b : CO_2 fixation using fast growing tree in Indonesia.

2a : CO_2 fixation by re-swamping by afforestation in South East Asia peat land.

2b : Reduction of CO_2 emission from developed peat land by the introduction of paddy field.

3a : Reduction of CH_4 emissions by water management of paddy fields in Indonesia and reduction of CH_4 emissions by suitable feeding to livestock.

The evaluation for 1a, 2a and 3a were partly shown below as examples.

1) 1a: Afforestation by using blasting of hardpan

Afforestation of *Eucaliptus* in holes made by blasting of the hardpan lying under eroded land in arid land of Western Australia.

This afforestation fixes CO_2 as trees.

The cost of CO_2 fixation was calculated to be Yen 16,000/t-C.

The CO_2 emitted by the preparation work for the afforestation was about 2% of CO_2 to be fixed.

2) 2a: CO_2 fixation by re-swamping by afforestation in South East Asia peat land.

The evaluation was done for the land use change from developed dry plantation land of oil palm trees to *Melaleuca* swamp. This change can cause the fixation of CO_2 by trees and prevention of oxidation of peat under the land and reduce 23t-C/ha•y. The reduction cost was calculated to be Yen 1,000/t-C.

The CO_2 emitted by the preparation work for the re-swamping was less than 0.1% of CO_2 to be fixed by the afforestation.

3) 3a: Reduction of CH_4 emissions by water management of paddy fields in Indonesia

CH_4 emissions can be reduced by 40% by water management of mid-season drainage in Indonesia. For that management, setting of concrete water gate is necessary in Kalimantan in Indonesia.

This method can result the reduction of CH_4 as 141kg/ha•y (0.8t-C/ha•y)

The setting and preparation work cost was calculated to be Yen 20,000/ha (Yen 2,000/ha•y).

It means the emission reduction cost is Yen 4,000/t-C. The CO_2 emitted by the preparation work for the preparation work is assumed to be less than 1% of CH_4 reduced (CO_2 equivalence) by the water management.

(3) As a tool for platform construction, a software framework for supporting the development of simulator was constructed. In this framework, a definition file is prepared for each simulator before development. This definition file contains information such as variable name, default value and variable explanation. This file is automatically converted to fragments of source code of the simulator, which implement standardized data input/output mechanism. Additionally, a mechanism for automatic check of equations in the model of simulator after each calculation was prepared.

4. Discussion

In this project, three typical ecosystems are studied: 1) forestry, 2) tropical wet -land, and 3) agricultural (i.e., cultivated, slash-and-burn, agricultural, and cattle lands). These three ecosystems have been expected to have high potential of global warming mitigation in the terrestrial ecosystem. GHG sink/source control technology development to mitigate the global warming is the project objective.

However, the research field expands to a wide range for attainment of the objective.

Therefore, a common platform was constructed for sharing information among researchers by gathering essential information on GHG sink/source control technologies of the three ecosystems from six research teams. On the platform, GHG reduction potential, effect of a developed technology implementation on environments and its cost are evaluated on the same basis.

A roadmap to implement developed technology is also included in the platform.

This platform construction management was useful for the advance of the project. The total GHG reduction potential by the technology developed in this project is calculated to be more than 10BtC in 20 years.

The highest potential exists in peat swamps in South East Asia where development done has promoted CO2 emissions by the change from swamp to dry land, and the potential value is 3.6BtC in 20 years.

The measures applicable to policy of environmental issues in a short time were clarified for each research team based on the evaluation result of cost, technology level and environmental impact. Most of the C reduction costs of measures are below $100/tC of the project target value.

The selected measures from each research theme are as follows:

1a; Afforestation in Western Australia arid land by a blasting method.

1b; Improvement of reforestation system in tropical forest applied to timber industry.

2a; Rewetting of developed peat swamp by planting trees.

2b; Improvement of paddy field in developed peat swamp.

3a; CH4 reduction by water management of Indonesia paddy field

The following table 2 shows the result.

Table.2 Summary of overviewed evaluation of GHG reduction cost, efficiency and potential

GHG reduction cost, efficiency & amount

テーマ	Reduction rate (tC/ha･y)	Cost (Yen/tC)	*Efficiency (20 years)	Reduction in 2020 (10^3tC/y)
1a	3.7	16,000	60	30
1b	1.2	1,000	600	10
2a	30	1,300	1,000	6,000
2b	18	2,000	(700)	10
3a	0.8	4,000	500	200
3b	1.7	600	(>100)	10
				Total 6.5MtC/y

* Efficiency = $\frac{\text{CO2 reduced in 20 years}}{\text{CO2 emitted for system construction}}$

Major Publications

1) S. Sinha, Sanjay Kumar, T. Matsumoto, H. Hamano and T. Kojima: Arid Land Geography, 26(S), 66-71 (2003) "Salt and Water Movement in Standard Toyoura Sand: Theoretical Estimation and Experimental Evaluation"
2) T. Kojima, J. Ishida, H. Hamano, K. Tahara and K. Yamada: Arid Land Geography, 26(S), 100-103 (2003) "Evaluation of Mixing Effects of Soil Conditioners under Dry Condition"
3) T. Kojima, E. Komaki, K. Hayakawa, S. Kato and H. Hamano: J. Arid Land Studies, 14(S), pp.151-154 (2004) "Quantitative Evaluative of Artificial Aggregate Formation"
4) Y. Abe, M. Taniguchi, H. Suganuma, M. Saito, Y. Yamamoto, K. Yamada, T. Kojima, Y. Egashira: J. Chem. Eng. Jpn., 36(4), 376-382 (2003) "Comparative Analysis Between Biomass and Topographic Features in an Arid Land, Western Australia"
5) Koichi Yamada, Toshinori Kojima, Yukuo Abe, Masahiro Saito, Yasuyuki Egashira, Nobuhide Takahashi, Kiyotaka Tahara and Jhon Law: J. Chem. Eng. Japan, 36, 328-3332 (2003) "Restructuring and afforestation of hardpan area to sequester carbon"
6) Egashira, D, Tomii, K. Ueyama, N. Takahashi, T. Kojima, Y. Abe, M. Saito, K. Yamada: J. Chem. Eng. Jpn., 36(4), 383-390 (2003) "Development of Integrated Simulator of Water Transport and Plant Growth as an Evaluation Tool of Arid Land Afforestation for CO2 Fixation"
7) N. Takahashi, K. Tahara, H., Utsugi, T. Kojima, Y. Egashira, Y. Abe, M. Saito, K. Yamada: J. Chem. Eng. Jpn., 36(4), 391-400 (2003) "Water Use Efficiency of Eucalyptus Camaldulensis Growing in Arid Regions in Western Australia"
8) T. Kojima, J. Ishida, H. Hamano, K. Tahara and K. Yamada: Arid Land Geography, 26(S),

100-103 (2003) “Evaluation of Mixing Effects of Soil Conditioners under Dry Condition”,

9) T. Saito, Y. Abe, H. Yasuda, T. Kojima and K. Yamada: Arid Land Geography, 26(S), 233-236 (2003) “Runoff Water Collection and Evaporation Control by means of Highly Permeable Ditch”,

10) N. Saito, S. Kato, T. Kojima, H. Hamano, K. Tahara, N. Takahashi and K. Yamada: J. Arid Land Studies, 14(S), pp.53-56 (2004) "Establishment of the Method to Estimate of Water Requirement Per Unit Carbon Fixation of a Tree in Arid Land"

11) T. Matsumoto, S. Kato, S. Sinha, Sanjay Kumar, Y. Abe, T. Kojima and K. Yamada: J. Arid Land Studies, 14(S), pp.147-150 (2004) " Estimation of Water Behavior for Afforestation in Desert of Western Australia using Stable Istope Ratio Analysis"

12) H. Hamano, J. Ishida, T. Kojima, Y. Abe, M. Saito, N. Takahashi and K. Yamada: J. Arid Land Studies, 14(S), pp.219-222 (2004) "Infiltration Properties of Arid Land with Various Conditions in Leonora, Western Australea"

13) T. Kojima, N. Asaka, J. Ishida, H. Hamano and K. Yamada: J. Arid Land Studies, 14(S), pp.223-226 (2004) "Development of a Model for Large Scale Water Balance in Arid Land”

14) Hideki Suganuma, Yukuo Abe, Masahiko Taniguchi, Masahiro Saito, Koichi Yamada: Journal of Arid Land Study, Vol. 14-S, pp85-88 (2004) "Fundamental Research on Detection of Stand Biomass Change in an Arid Rangeland."

15) Hideki Suganuma, Yukuo Abe, Masahiko Taniguchi, Masahiro Saito, Koichi Yamada: Journal of Arid Land Study, Vol. 14-S, pp85-88 (2004) "Fundamental Research on Detection of Stand Biomass Change in an Arid Rangeland.”

16) T. Hirukawa, N. Asak, C. Naito, H. Hamano, T. Kojima and K. Yamada : Proceeding of the Fifth Asia Pacific Conference on Sustainable Energy and Environment Technologies (2005) “A modeling methodology of large scale water balance for selection of afforestation site”

17) T. Kojima, S. Kaneoya, E. Komaki, H. Hamano, S. Kato and M. Matsukata: Proceeding of the Fifth Asia Pacific Conference on Sustainable Energy and Environment Technologies (2005) “Evaluation of mixing effect of various zeolites on soil properties”

18) E. Komaki, S. Kat, H. Hamano and T. Kojima : Proceeding of the Fifth Asia Pacific Conference on Sustainable Energy and Environment Technologies (2005) “Long term variation in soil physidal properties by artificial aggregate formation”

19) H. Hamano, N. Saito, T. Kojima, S. Kato, M. Saito, A. Kinnear and K. Yamada: J. Arid Land Studies, 15-4, 231-234 (2006) "Death of Trees in the Wheat Belt Western Australia: Indentification of the Causes by Chemical Analysis of Soil"

20) S. Kawarasaki, S. Kaneoya, H. Tanouchi, H. Hamano, T. Kojima and K. Yamada: J. Arid Land Studies, 15-4, 235-238 (2006) "Effect of temperature and light on germination of 12 afforested trees in South Western Australia"

21) Adrianne Kinnerar, Peter Curry, T. Kojima and K. Yamada: J. Arid Land Studies, 15-4, 239-242 (2006) "Soil Mites in Re-afforested, Semi-arid Landscapes in Western Australia"

22) T. Hirukawa, N. Asaka, H. Hamano, K. Yamada and T. Kojima: J. Arid Land Studies, 15-4,

247-250 (2006) "A Modeling Methodology of Large Scale Water Balance and Salt Accumulation for Afforestation in Arid Land"

23) K. Shiono, H. Suganuma, Y. Abe, H. Tanouchi, H. Utsugi, M. Saito, N. Takahashi, T. Kojima and K. Yamada: J. Arid Land Studies, 15-4, 251-254 (2006) "Biomass Growth Estimation of an Afforestation Site and Natural Forests in an Arid Land of Western Australia"

24) Y. Egashira, M. Shibata, K. Ueyama, H. Utsugi, N. Takahashi, S. Kawarasaki. T. Kojima and K. Yamada: J. Arid Land Studies, 15-4, 263-266 (2006) "Development of Tree Growth Simulator Based on Process Model of Photosynthesis for Eucalyptus Camaldulensis in Arid Land"

25) N. Takahashi, H. Hamano, Y. Abe, T. Kojima and K. Yamada: "Effect of Calcined Bauxite as a Water-holding Material and a Way of Mixing it with Soil on Tree Growth", J. Arid Land Studies, 15-4, 275-278 (2006)

26) Hideki Suganuma, Y. Abe, Masahiko Taniguchi, H. Tanouchi, Hajime Utsugi, T. Kojima, K. Yamada: Forest Ecology and Management, 222, 75-87 (2006) "Stand biomass estimation method by canopy coverage for application to remote sensing in an arid area of Western Australia"

27) Tsuyoshi Matsumoto, Toshinori Kojima: J. Arid Land Studies, 16-1, 53-59 (2006) "Simulations of salt accumulation at soil surface under different annual precipitation amounts in arid Leonora area, Western Australia"

28) Kumada, S., Kawamishi, T., Hayashi Y., Ogomori, K., Kobayashi, Y., Takahashi, N., Saito, M, Hamano, H., Kojima, T., Yamada, K. Journal of Ecotechnology Research 12, 167-170 (2006) "Litter and Soil Carbon Dynamics Model in Arid Forest Ecosystems: Application to Sturt Meadows Experiments in Western Australia."

29) Hiroshi Iwasaki, Nobuhide Takahashi, Atsushi Kobayashi, and Koichi Yamada Journal of the Japan Institute of Energy, 85, 542-551 (2006) "Improvement of the Fermentation Process for Bioethanol -High Speed Fermentation Process-"