4）微生物部門

Experiment Summary of Microbe Section

in

Maize Quality Improvement Research Center Project
(MQIRC PROJECT, DoA/JICA)

for

Three Years from 1988 to 1990 Cropping Season

1988. Conducted Reesearch Subject.
(Microbe Section).

1. Analysis of contamination factors.
(1). Correlation between cultural practices and aflatoxin contamination.
Code No. III-1-(1).
Related Code No. I-1-(1).
1-1. Studies on the aflatoxin content of maize cultivated under differnt conditions.
(2). Correlation between post-harvest storing/processing and aflatoxin contamination.
Code No. III-1-(2).
Related Code No. II-1-(2).
2-1. Studies on the aflatoxin content in maize shelled by different types of corn sheller under various operating conditions and moisture content of maize.
3. Countermeasure of aflatoxin prevention.
(3). Aflatoxin prevention by controlling A. flavus.
Code No. III-3-(3)
3-A. Studies on the effect of ammonia treatment for prevention of fungus invasion on ear and grain maize.

1989. Conducted Research Subject.
(Microbe Section).

1. Analysis of contamination factors.
(1). Correlation between cultural practices and aflatoxin contamination.
Code No. III-1-(1).
Related Code No. I-1-(1).
(2). Correlation between post-harvest storing/processing and aflatoxin contamination.
Code No. III-1-(2).
Related Code. No. II-1-(2).
(3). Characteristics of A. flavus relating aflatoxin contamination.
Code No. III-1-(3).
3-1. Studies on A. flavus and aflatoxin contamination routes in Thai maize.
3-2. Studies on the population of A. flavus isolated from soil and air.
3-3. Water activity of maize and growth of A. flavus.
3-4. Equilibrium moisture content of maize and growth of A. flavus.
2. Improvement of test techniques.
(1). Improvement of simple and rapid analytical method of aflatoxin.
Code No. III-2-(1).
1-A&B. Aflatoxin content in stored maize determined by Immunoassey (ELISA).

1990. Conducted Research Subject.
(Microbe Section).

1. Analysis of contamination factors.
(1). Correlation between cultural practices and aflatoxin contamination.
Code No. III-1-(1).
Related Code No. I-1-(1).
(2). Correlation between post-harvest storing/processing and aflatoxin contamination.
Code No. III-1-(2).
Related Code No. II-1-(2).
(3). Characteristics of A. flavus relating aflatoxin contamination.
Code No. III-1-(3).
3-5. Studies on the population of A. flavus and aflatoxin content in ear maize stored with and without husk in farmer's crib.
3-6. A. flavus infection and contamination in the maize field.
3-7. Identification of aflatoxin producing ability of A. flavus by coconut powder and coconut cream agr.
3-8. Studies on A. flavus infection and aflatoxin contamination during sun dry in the middleman and laboratory scale.
2. Improvement of test techniques.
(1). Improvement of simple and rapid analytical method of aflatoxin.
Code No. III-2-(1).
1-C. Improvement of the mini-column method for the aflatoxin content in maize.
3. Countermeasure of aflatoxin prevention.
(3). Aflatoxin prevention by controlling A. flavus.
Code No. III-3-(3).
3-B-1. Control of A. flavus and aflatoxin contamination of high moisture content of maize in anaerobic condition.
3-B-2. Population dynamic of microorganism involved in maize stored in anaerobic condition.

1991. Research Implementation Plan.
(Microbe Section).

1. Analysis of contamination factors.
(1). Correlation between cultural practices and aflatoxin contamination.
Code No. III-1-(1).
Related Code No. I-1-(1).
(2). Correlation between post-harvest storage/processing and aflatoxin contamination.
Code No. III-1-(2).
Related Code No. II-1-(2).
(3). Characteristics of Aspergillus flavus relating aflatoxin contamination.
Code No. III-1-(3).
3-9. Studies on the growth and aflatoxin production by A. flavus various strains from maize, air, and soil in maize field.
3-10. Changing of chenical property and aflatoxin formation in maize.
3-11. Changing of physical property and aflatoxin formation in maize.
3-12. Study on the contamination of A. flavus from insect damaged cob.
2. Improvement of test technics.
(1). Improvement of simple and rapid analytical method of flatoxin.
Code No. III-2-(1)
1-C. Improvement of nini-column method for the aflatoxin content in maize.
3. Counter measure of aflatoxin prevention.
(3). Aflatoxin prevention by controlling A. flavus.
Code No. III-3-(3).
3-B-2. Effect of anaerobic condition to the growth of A. flavus.
3-B-3. Control of A. flavus and aflatoxin contamination of various moisture content of maize in anaerobic condition.
3-B-4. Population dynamic of microorganism involved in maize stored in anaerobic condition.

III-1-(1).

Joint Work with Agronomy Section (1988).

1. Long term study on the relationship of the environmental conditions that cause aflatoxin incidence in maize.
   Related Code No. I-1-(1)-B, G & J-(b) (1988~1992).
2. Effect of different harvest methods, moisture conditions and storage periods on aflatoxin contamination in maize.
   Related Code No. I-1-(1)-H & G. (1988~1989).
3. Effect of plant density and nitrogen application on aflatoxin contamination.
   Related Code No. I-1-(1)-D. (1988~1989).
4. Effect of crop rotation on Aspergillus spp. in the soil.
   Related Code No. I-1-(1)-C & B (1988~1990).

Joint Work with Agronomy Section (1989).

1. Long term study on the relationship of the environmental conditions that cause aflatoxin incidence in maize.
   Related Code No. I-1-(1)-B, E, G & J-(b) (1989).
2. Effects of different harvest methods, moisture conditions and storage periods on aflatoxin contamination in maize.
   Related Code No. I-1-(1)-H & G (1989).
3. Effect of plant density and nitrogen application on aflatoxin contamination.
   Related Code No. I-1-(1)-D
4. Effect of crop rotation on Aspergillus spp. in the soil.
   Related Code No. I-1-(1)-C & B (1989)
5. Effect of nitrogen regarding prevention of aflatoxin Contamination by the inoculatiom method.
   Related Code No. I-1-(1)-D (1989).
6. Evaluation of insect damage that occures under field condition.
   Related Code No. I-1-(1)-F & B (1989).
7. Relation between kernel type and resistance to fungus infection after inoculation.
   Related Code No. I-1-(1)-A (1989).
8. Relation between environmental factors and fungus infection.
   Related Code No. III-1-(1)-A + B (1989).
9. Monitoring aflatoxin occurence in the major production areas.
   Related Code No. I-1-(1)-J, I-3-(1)-A (1989).

Joint Work with Agronomy Section (1990).

1. Long term study on the relationship of the environmental conditions that cause aflatoxin incidence in maize.
   Related Code No. I-1-(1)-B, E, G & J-(b) (1990).
2. Effect of different harvest methods, moisture conditions and storage periods on aflatoxin contamination in maize.
   Related Code No. I-1-(1)-H & G (1990).
3. Effect of plant density and nitrigen application on aflatoxin contamination.
   Related Code No. I-1-(1)-D (1990).
4. Effect of crop rotation on Aspergillus spp. in the soil.
   Related Code No. I-1-(1)-C & B (1990).
5. Effect of nitrogen regarding prevention of aflatoxin contamination by the inoculation method.
   Related Code No. I-1-(1)-D (1990).
6. Large scale practice on concerning harvest methods and aflatoxin occurence in maize.
   Related Code No. I-3-(1) (1990~1991).
7. Reduction of A. flavus infection and aflatoxin production by pottasium application.
   Related Code No. I-1-(1)-D (1990).

Research Implementation Plan:
1. Analysis of contamination factors.
(1) Correlation between cultural practices and aflatoxin contamination.
Code No. III-1-(1).
Related Code No. I-1-(1)~

Research Membber:
Arunsri Wongurai, Prawat Tan Boon-ek, Prasop Thepayasuvan, Sukapong Wayuparp, Veerawat Ninratanakul and Naronsak Senanarong (DoA).
KatsusukeArai, Teruhiko Nibe (JICA).

These subjects were studied as the joint research work by the Microbe and Agronomy sections. The purpose of studies were to clarify the relationship between aflatoxin contamination in maize and some factors occured in cultivation and harvesting period; physiological, ecological and morphological features; environmental factors including climate; soil and outbreak of insect pest or disease etc. The maize cultivation and sample preparation were made by Agronomy section and the microbiological study and aflatoxin analysis have been done by Micorbe section.
Further details may be reffered to in the summary report of Agronomy Section.

Achivement:

Problems remained:

III-1-(2).
Joint Work with Post-Harvest section.
1. Study on the relation between types of corn sheller, operational conditions, kernel moisture content and aflatoxin contamination in maize.
   Related Code No. II-1-(2)-B-(a) & (b) (1988~1989).
2. Ammonia treatment of maize to control Aspergillus spp. and so prevent aflatoxin contamination.
   Related Code No. II-3-(2)-C-(a)-(i) (1988~1989).

Joint Work with Post-Harvest Section (1989).
1. Study on the relationship between damage on kernel, kernel moisture content and aflatoxin contamination.
   Related Code No. II-1-(2)-B (1989).
2. Estimation on increase of damaged kernel ratio during handling.
   Related Code No. II-1-(2)-C-(a) & (c) (1989).
3. Allowable duration for delayed drying in the post-harvest process of maize.
   Related Code No. III-1-(2) (1989~1990).

Joint Work Post-Harvest Section (1990).
1. Study on the relationship between damage on kernel, kernel moisture content and aflatoxin contamination.
   Related Code No. II-1-(2)-B (1990).
2. Development of simple drying method-2.
   Research on drying ear maize with vinyl plastic house.
   Related Code No. II-3-(2)-B-(b) (1990).
3. Allowable duration for delayed drying in the post-harvest process of maize.
   Related Code No. II-1-(2) (1990).

Research Implementation Plan:
1. Analysis of contamination factors.
(2) Correlation between post-harvest storage/processing and aflatoxin contamination.
   Code No. III-1-(2).
   Related Code No. II-1-(2) & II-3-(2).

Research Member:
Arunsri Wongurai, Prawat Tan Boon-ek, Nitat Tangpinijkul, Pimol Wuttisin, Chaiwat Paosantdpanich and Sriwai Singhgajen (DoA).
Katsusuke Arai, Yukio Azuma, Mikio Kamo, Akira Matsuzaki and Makoto Kobayashi (JICA).

Summary:
These subjects were studied as the joint work by the Microbe and Post-Harvest Sections. The purpose of studies were to clarify the relationship between aflatoxin contamination and post-harvest techniques, e. g., chemical treatment to control growth of A. flavus, structure and improvement of shelling machine, drying process and storing of maize.
The maize samples were prepared by Post-Harvest Section and the microbiological experiments and aflatoxin analysis have been done by Microbe Section.
Further details may be reffered to in the summary report of Post-Harvest Section.

Achivement:

Problems remained:

III-1-(1)-1.
Studies on the aflatoxin content of maize cultivated under different conditions.

Research Implementation Plan:
1. Analysis of contamination factors.
(1) Correlation between cultural practices and aflatoxin contamination.
Code No. III-1-(1)-1, (1988-1990).
Related Code No. I-1-(1).

Research Member:
Arunsri Wongurai, Prawat Tan Boon-ek, Prasop Thepayasuvan, Sukapong Wayuparp, Veerawat Ninratanakul and Narongsak Senanarong (DoA).
Katsusuke Arai, Teruhiko Nibe (JICA).

Summary:
This subject was studied as a joint research work by the Microbe and Agronomy Sections.
The studies were carried out to clarify the relationship between aflatoxin contamination and maize varieties; its physiological, ecological and morphological features; enviromental factors including climate; soil and outbreak of insect pest or disease; and finally cultivation and harvesting practices.
The microbiological experiments have been done by usual manner and the analytical method used to detect aflatoxin contamination were the BGYF and TLC methods.
Further details may be reffered to in the summary report of Agronomy Section.

Achivement:

Prblems remained:

III-1-(2)-1.
Studies on the aflatoxin content in maize shelled by different types of corn sheller under various operating conditions and moisture contents.

Research Implementation Plan:
1. Analysis of contamination factors.
(2). Correlation between post-harvest storage/processing and aflatoxin contamination.
Code No. III-1-(2)-1 (1988-1990).
Related Code No. II-1-(2).
" II-3-(2).

Research Member:
Arunsri Wongurai, Prawat Tan Boon-ek, Nitat Tangpinijkul, Pimol Wuttisin, Chaiwat Paosantdpanich and Sriwai Singhagajen (DoA).
Katsusuke Arai, Makoto Kobayashi (JICA).

Summary:
This subject was studied as a joint research project by the Microbe and Post-harvest Sections.
Mechanical damage to grain when shelled is one of the biggest causes of infection by A. flavus and also the occurence of mechanical damage to grain is to grain is closely related to the moisture content.
The moisture content of the maize was adjusted to 4 levels in the field and they were shelled by 4 types of corn sheller under various operatin conditions. Shelled grain was packed in gunny bags and stored 4 weeks. Periodically samples samples were extracted and sent to the Microbe Section for aflatoxin analysis.
The analytical mmethods used to detect aflatoxin contamination were BGYF and TLC methods.
Details of the results may be reffered to in the summary report, Code No. II-1-(2)-B-(a) & (b)

Achivement:

Problems remained:

III-1-(3)-1.

Studies on A. flavus and Aflatoxin Contamination Routes in Thai Maize.

Research Implementation Plan:
1. Analysis of contamination factors.
(3). Characteristics of A. flavus relating aflatoxin contamination.
Code No. III-1-(3)-1 (1989).

Research Member:
Suparat Kositcharoenkul, Kanjana Bhudhasamai, Prawat Tan Boon-ek (DoA).
Katsusuke Arai (JICA).

Summary:
To know the actual situation of aflatoxin content and A. flavus contamination route in Thai maize, several observation site were set up in north and central maize production area and taken samples for analysis periodically.
The samples of air and soil in the maize fields, ear and shelled maize, air and dust in the farmers and middlemen's warehouses were collected for the microbiological studies. The high population of A. flavus was observed in the soil samples of fields and both warehouses. Freshely harvested ear maize and shelled maize were cleaner than long term stored maize. A. flavus density in the air was very high near by working shelling machine, but normally very low in the maize field. The shelling process is presumed as a main infestation route by A. flavus. Although many variations of aflatoxin content in maize were observed, shelled maize is usually highly contaminated by A. flavus and aflatoxin as compared with ear maize. It seems to be no regional difference in A. flavus and aflatoxin contamination.

Achivement: 90 %

Problems remained:

III-1-(3)-2.
Aflatoxin Producing Ability of the Various Strains of A. flavus Isolated from Maize, Soil, Air etc.

Research Implementation Plan:
1. Analysis of contamination factors.
(3). Characteristics of A. flavus relating aflatoxin contamination.
Code No. III-1-(3)-2 (1989).

Research Member:
Arunsri Wongurai, Prawat Tan Boon-ek (DoA).
Tetsuhisa Goto, Katsusuke Arai (JICA).

Summary:
A. flavus is one of common fungi in Thailand. It is frequentry found in maize, both ear and grains but also in the part of maize plant, air and soil in maize field, dust in farmer's or merchant's godown, silo etc. However, it is presumed that there would be slight differences in morphorogical or toxicological characteristics among the strains of A. flavus, for instance, color of colony, screlotium formation, aflatoxin producing ability etc.
In this study, 121 strains of A. flavus isolated from various samples, such as maize, air, soil and dust in the warehouses etc. were examined on aflatoxin producing ability cultivated in GY media (Glucose-Yeast media) using ELISA, TLC qualitative test and AFPA media. Among them about 70% of strains were identified as aflatoxin producer and 30% were sclerotium formation types. The relation was not clear between aflatoxin producing ability and sclerotium formation. Judging the aflatoxin producing ability by the colony color in AFPA media was difficult. Some colonies showed flurorescent in the revers side of the media.

Achivement: 80 %

Problems remained:
Background histry of A. flavus strains should be cleared.
Quantitative analysis of aflatoxin should be done by TLC or HPLC.
Aflatoxin producing ability test by coconut powder and cream agar media should be included in this subject.

Table 1 Morphological Characteristics of Aflatoxin Productivity of A.flavus in Thailand

No.	Source	Morphology*	AFPA medium*				UV-FL	Immuno assey (ppb)	TLC qualt. test	Remarks
			dia(m/m)	color	Sclero.					
1	A-1	Whitish green	40	OY	++	(120hr.)	-	>>80	+++ B1 B2	Phrapht, field,
	(Air)	Sclerotium(+++)	41	OY	+++		-			air, Jul/89
2	A-2	green	39	OY	-		+	22	ND	Phrapht, field,
			38	OY	-		+			air, Sep/89
3	A-3	green	39x38	OY	-		+	ND	ND	
			38	OYD	-		-			
4	A-4	green	38	OY	+++		+	ND	ND	
			33	OY	-		±			
5	A-5	green	38	OYD	+		-	ND	ND	
			39	OYD	++		±			
6	S-1	green	42	OYD	-		-	>>80	++ B1 B2	
	(Soil)		39	OYP	-		±			
7	S-2	green	41	OYD	-		-	>>80	ND	
		Sc(++)	36	OYD	+++		-			
8	S-3	green	36	OY	-		+	19	ND	
			36	OYD	-		±			
9	S-4	dark green	42	OYD	-		±	ND	ND	
			39	OY	-		+			
10	S-5	green						ND	ND	
			35	OY	-		+			
11	S-6	white-yellow	38	OY	-		+	>>80	++ B1 B2	
		Sc(+++)	38	OY	-		+			
12	S-7	white-yellow	38	OYB	-		-	>>80	++B1B2 G1G2	
		Sc(+++)	39	OYD	-		-			
13	S-8	green	44	OY	-		-	>>80	++ B1 B2	
			46	OY	-		±			
14	S-9	green	36	OY	-		-	30	ND	
			39	OYD	-		±			
15	S-10	green	32	OY	-		+	29	ND	
		SC(+)	35	OYD	-		-			
16	S-11	green	43	OYD	-		±	25	ND	
			41	OY	-		+			
17	S-12	dark green	38	OYD	+		-	>80	+ B1	
		Sc(+)	42	OYD	+		-			
18	S-13	dark	39	OYP	-		+	ND	ND	
		Sc(+)	41	OY	-		-			
19	S-14	green	36	OYP	-		+	ND	ND	
			37	OY	-		+			
20	S-15	green	40	OYD	-		+	19	ND	
			37	OYP	-		+			

Table 2
AF productivity of A.flavus (121 strains)

Toxin Productivity AFB1 (ELISA)	No. of Toxin Producer in 121 strains	No. of Sclerotium formation in 121 strains
>80 ppb	46(38%)	23(19%)
79~50~21	14(12%)	7(6%)
20~1	26(22%)	9(7%)
(total)	(86 72%)	(39 32%)
ND	35(29%)	18(15%)

ND : Not detected

Table 3
AF productivity of A.flavus (in 24 strains)

Source	No. of Strain	Place & Month	Toxin Production AFB1	(ELISA)
Air	2	Phraphuttabat, field	>80 (1)	Soloro (1)
		(Jul/89)	22 (1)	
"	2	Lopburi, Silo	>80 (2)	" (1)
		(Jul/89)		
Soil	3	PPB, field (Jul/89)	ND (3)	" (1)
	4	Lpburi, field	>80 (2)	" -
		(Jul/89)	11 (1)	" -
			ND (1)	" -
Dust	4	Pakchong, middleman	3 (1)	" (1)
		godown (Jul/89)	ND (3)	" (3)
Maize	2	Chiang Rai, farmer's	8 (1)	" -
		"Ear" Store house	ND (1)	" (1)
		(Jul/89)		
Maize	1	PPB, kept in farmer	38 (1)	" -
		"Ear" Store house		
		(Jul/89)		
Maize	6	PPB, "Ear" kept in	>80 (3)	" (3)
		the field (Jul/89)	38 (1)	" -
			ND (2)	" (1)
Total	24			

( ) show the number of strain

Remarks :

>80 as strong
79~21 medium
20~ weak

Toxin producer (in 24 strains)

strong 8 (33%)
medium 3 (13%)
weak 3 (13%)
No toxin 10 (42%)

Sources

A : from Air
B : from Soil
C : from Maize

Morphology

Sc : Sclerotium
Sc (+) : little
(++) : medium
(+++) : many

Color

OY : orange·yellow
OYP : pale orange yellow
OYD : dark orange yellow
OYB : brownish orange yellow
Br : brown

Sclero (Sclerotium)

+ : little
++ : medium
+++ : many

UV-FL (check fluoressent of AFPA petri dish under UV light)

- : cannot identified colony
+ : slightly can identified colony
+ : clearly can identified colony

Immuno assey

>>80 : more than 80 ppb, ca. 500~600 ppb
>80 : more than 80 ppb, ca. 250~300 ppb
> 80 : nearly 80 ppb
ND : not detected

TLC qualitative test

+++ : strong toxin producibility
++ : medium toxin productivity
+ : weak toxin productivity
ND : not detected

III-1-(3)-3.

Water Activity of Maize and Growth of A. flavus.

Research Implementation Plan:
1. Analysis of contamination factors.
(3). Characteristics of A. flavus relating aflatoxin contamination.
Code No. III-1-(3)-3 (1989).

Research Member:
Arunsri Wongurai, Prawat Tan Boon-ek (DoA).
Osamu Tsuruta, Katsusuke Arai (JICA).

Summary:
The term of Water activity (Aw), an index of free water in food, is often used in the field of micobiology. The free water in food is available by microorganisms but the growth of fungi or bacteria has proper relation with Aw. Accordingly, we examined the Aw of Thai maize, Suwan-1, and observed critical Aw value for the growth of A. flavus.
The maize samples with various moisture content were prepared and measured Aw by Aw-Wert-Messer (Durotherm, W. Germany), a type of hair hygrometer. At the same time, the growth of A. flavus inoculated in various Aw of maize was observed. The critical Aw of maize for growth of A. flavus seems to be 0.85.

Achivement: 100 %

Problems remained:
Apply to other fungi, e.g., Fusarium sp., Penicillium sp. ,etc.

参 考

Minimum Water activity (Aw) required for growth of microorganisms

Microbe	min.Aw
Bacteria	0.90
Yeast	0.88
Fungi	0.80
Xeric fungi	0.65
〃 yeast	0.62~0.60

Table 1

The growth of A. flavus on various Aw of kernels after inoculated for 7 days at 28 °C

Aw	A. flavus	Aw	A. flavus	Aw	A. flavus
1.00	++++	0.93	++	0.83	-
0.99	++++	0.93	-	0.82	-
0.98	++++	0.92	++	0.81	-
0.98	+++	0.92	-	0.80	-
0.98*	-	0.91	+	0.78	-
0.97	++++	0.91	-	0.76	-
0.97	+++	0.90	++	0.75	-
0.97	++	0.90	-	0.74	-
0.97*	-	0.89	++	0.68	-
0.96	+++	0.89	+	0.65	-
0.96	++	0.89	-	0.62	-
0.95	++++	0.88	-	0.58	-
0.95	+++	0.87	+	0.43	-
0.95	++	0.87	-		
0.95	+	0.86	-		
0.94	+++	0.85	+		
0.94	++	0.85	-		
0.94	-	0.84	-		

* germinated + 1~2 kernels infected +++ highly infected

\- no infect ++ few kernels infected ++++ all kernels infected

Water activity and Equilibrium Moisture Content of Thai Maize and Growth of A.flavus

Miss. Arunsri Wongurai*
Mr. Prawat Tanboon-ek*
Mr. Katsusuke ARAI**

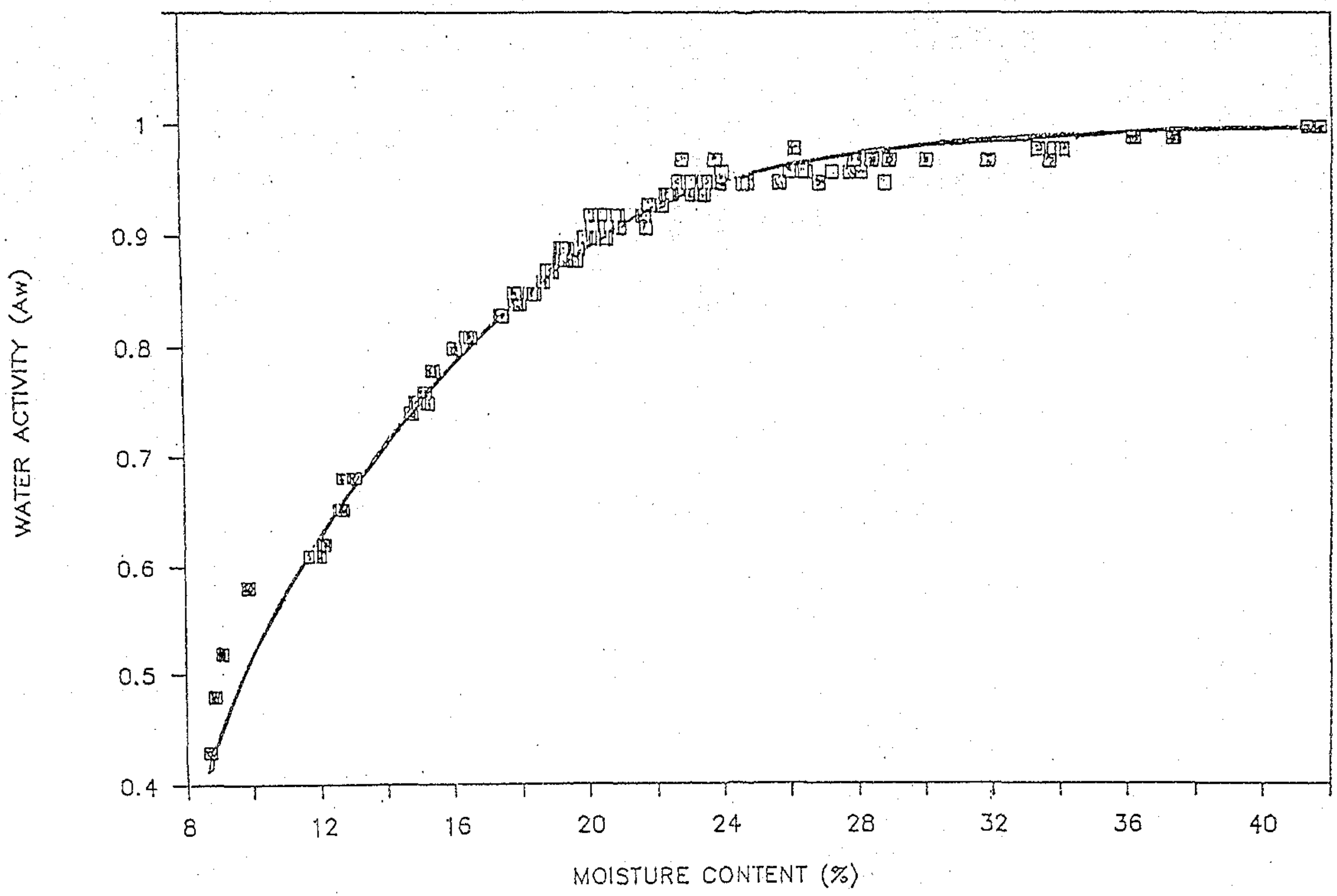
(1) The Water activity (Aw), an index of the amount of free water in the maiz affecting the growth of fungus, was studied.
There are two categories of water in the foods, one is bond water which combined with water soluble matter of the foods, such as salt or sugar, or hydrated with protein or starch. The other is called "free water" which is no restrain from the component in the foods utilizable by fungus.
Theoretically, Aw is expressed as P/P_o, where p_o is the vapor pressure of pure water and P is the vapor pressure from the material. Aw of the material can, generally, be measured the relative humidity occured from the material by means of the airtight container devised with the relative humidity meter.

(2) Moisture content in maize is largely influenced by surrounding humidity during drying or storing process. When maize, both wet and dry, were kept under the humidity for a long time, finally moisture content of maize reach to equilibrium for the humidity which defined as the equilibrium moisture content of the maize. Accordingly, it is quite necessary to pay attention on the surrounding humidity for effective drying or storing of maize without problems, especially, contamination by fungus due to absorbed high moisture content in the maize.

---

* Division of Plantpathology and microbiology, DoA
** Maize quality Improvement Research Center Project (JICA), DoA

Figure 1 RELATION BETWEEN M/C & Aw



III-1-(3)-4.
Equilibrium Moisture Content of Maize and Growth of A. flavus.

Research Implementation Plan:
1. Analysis of contamination factors.
(3). Characteristics of A. flavus relating aflatoxin contamination.
Code No. III-1-(3)-4 (1989).

Research Member:
Arunsri Wongurai, Prawat Tan Boon-ek (DoA).
Osamu Tsuruta, Katsusuke Arai (JICA).

Summary:
Moisture content in maize is largely influenced by surrounding atmosphere during drying or storing. Drying of wet maize will not be able to achived in high humid condition and finally molds grow on the grain, while well dried maize will absorb water when left it in high humid condition for long time, and grain might be contaminated by mold. Basic data of absorb and release water in maize must be useful for drying or storing.
Wet and dry maize samples were kept in the constant humidity prepared by several kinds of saturated inorganic salt solution for 9 weeks. Moisture content in maize were periodically determined. The equilibrium moisture content curves of maize, both absorb and release, were prepared. At the high humidity conditions, 93 and 84% RH, moisture content of maize equilibrated to 20~21 and 16~17% respctively, and mold grow on the surface of maize within 8 weeks. At the condition of below 80, 75 and 70% RH, moisture content of maize equilibrated to 15~16%, 14~15% and 13~14% respectively after 9 weeks, and no mold was observed.

Achivement: 100 %

Problems remained:

Table 1
Equilibrium Moisture Content of Maize
(Suwan 1)

	Week	0	1	3	5	7	8	9	Re.
Saturate salt solution & RH		start 25/ Oct/ 89	M/C 31/ Oct/ 89	M/C 14/ Nov/ 89	M/C 28/ Nov/ 89	M/C 12/ Dec/ 89	M/C 19/ Dec/ 89	M/C 26/ Dec/ 89	
		%	%	%	%	%	%	%	
KNO_3	D	11.59	19.52	19.37	19.62	-	-	-	*
92.6 RH%	W	33.75	22.38	21.41	21.33	-	-	-	*
KCl	D	11.59	16.53	15.72	16.10	16.54	-	-	**
84.2 RH%	W	33.75	18.05	17.34	17.26	16.97	-	-	**
KBr	D	11.59	15.68	14.03	12.66	14.68	15.22	15.13	
80.8 RH%	W	33.75	17.00	16.01	13.74	16.12	16.43	16.03	
NaCl	D	11.59	14.54	14.08	13.96	13.88	14.23	14.02	
75.5 RH%	W	33.75	15.93	15.21	15.05	14.87	14.59	14.87	
KI	D	11.59	13.73	13.05	14.78	12.72	12.97	12.80	
70.2 RH%	W	33.75	14.87	14.44	15.98	13.66	13.97	13.70	

D : started dried maize
W : started wet maize

* : molded, 7 days (+), DB(dried broken) & DW(dried whole)
28/(28)
** : molded, 7 days (-), 21 days (+), DB(dried broken)
9/(22)

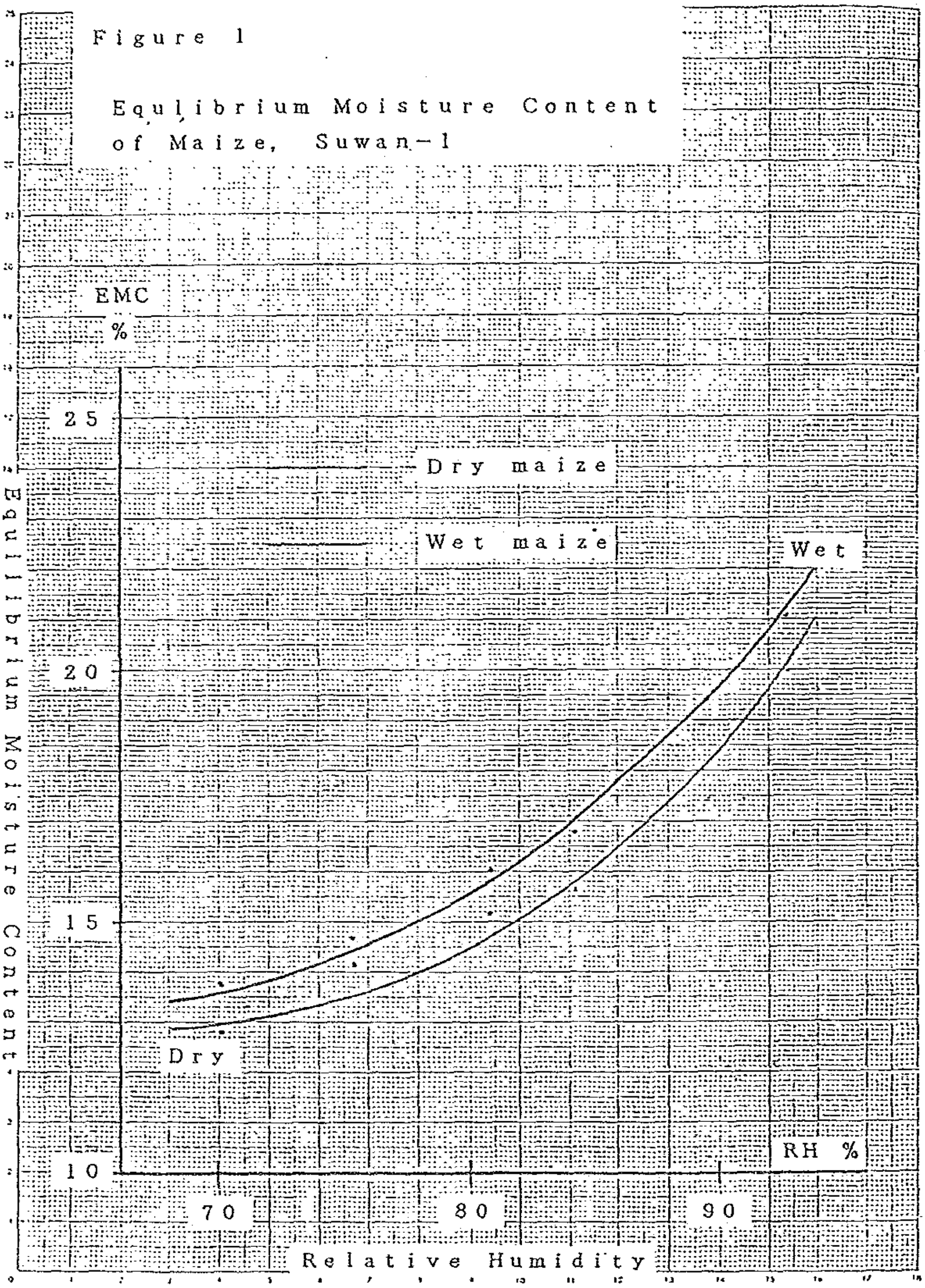
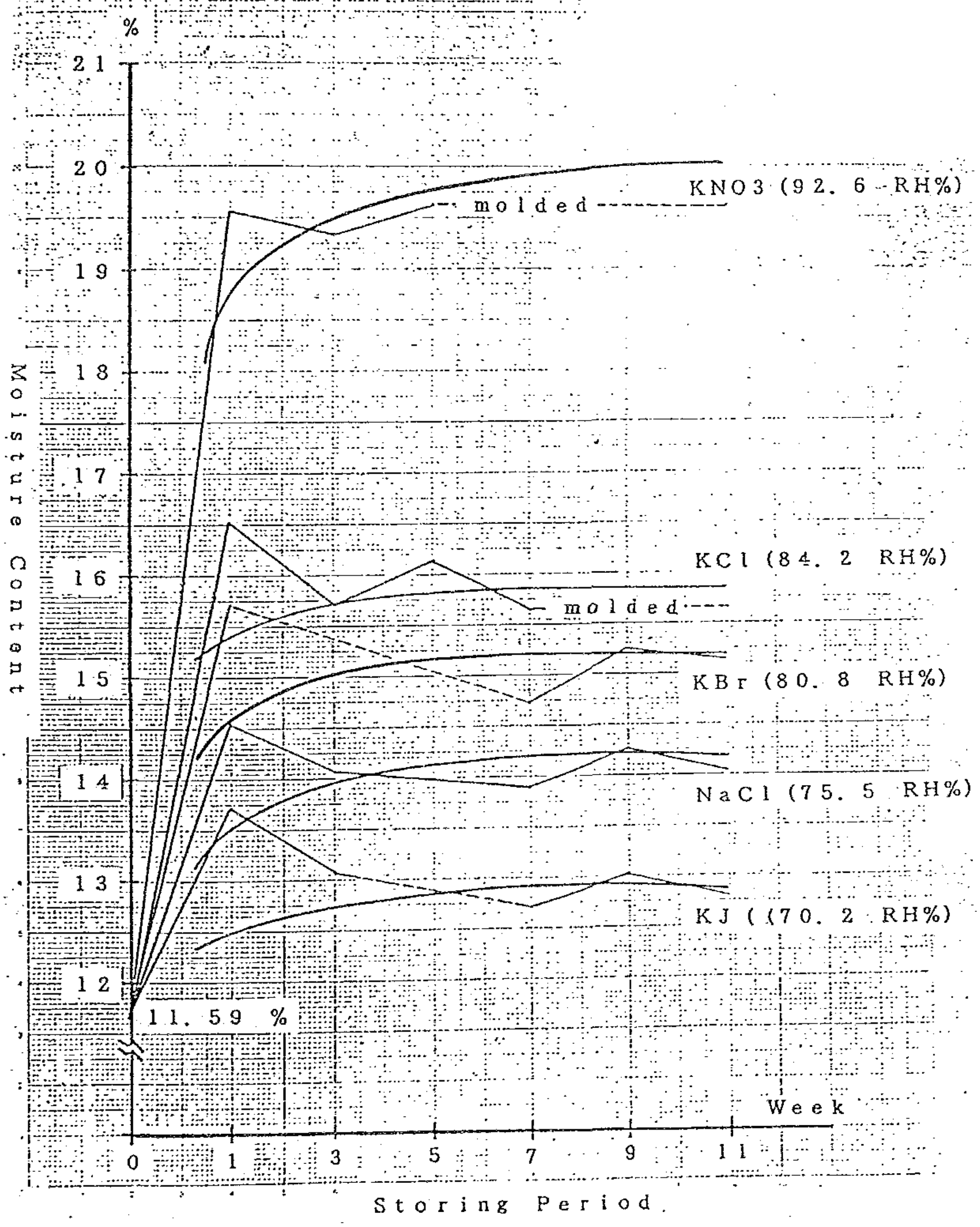
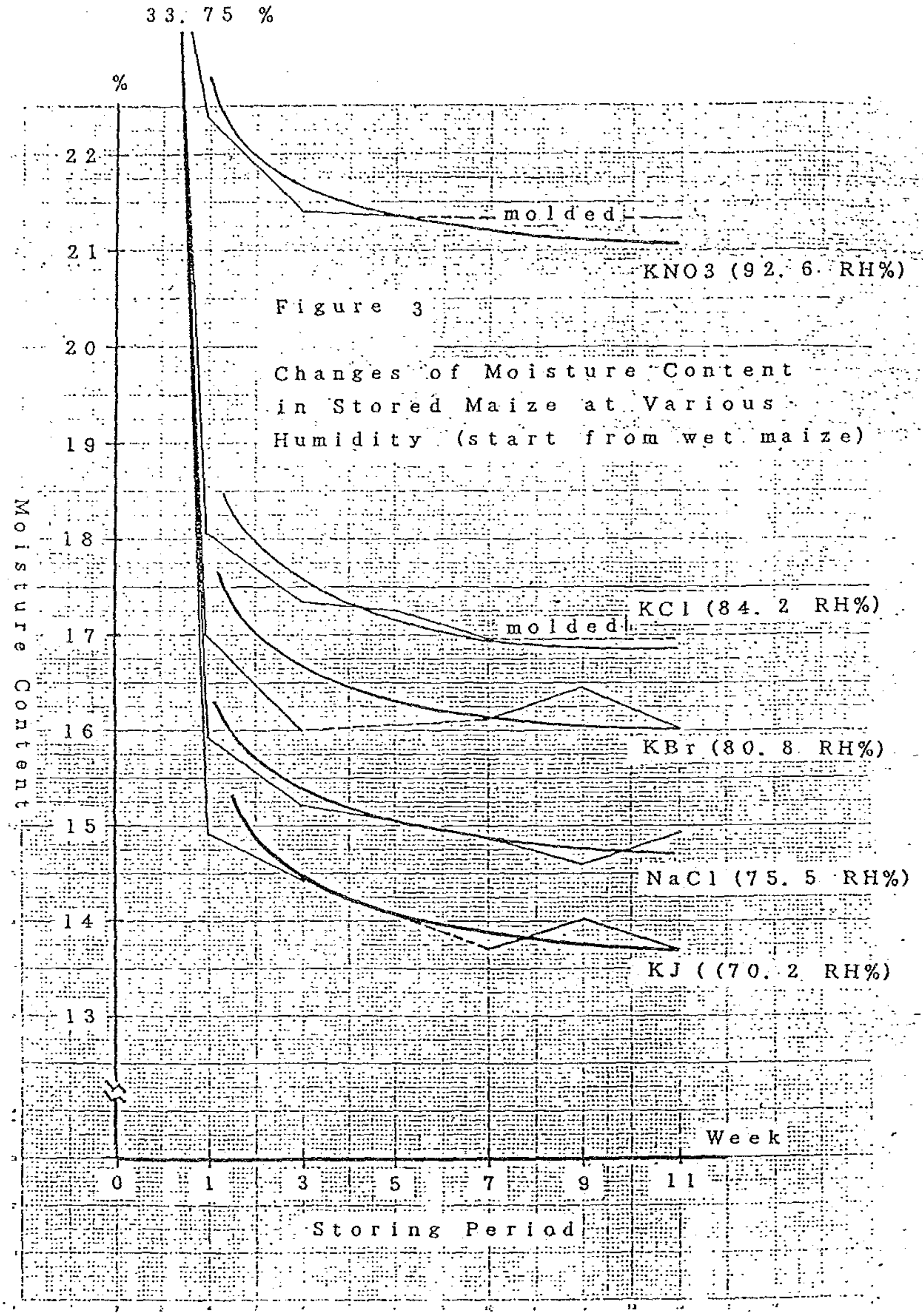


Figure 1
Equlibrium Moisture Content
of Maize, Suwan-1
EMC
%
25
20
15
10
Dry maize
Wet maize
Wet
Dry
RH %
70
80
90
Relative Humidity
Equilibrium Moisture Content

Figure 2

Changes of Moisture Content in Maize Stored at Various Humidity (start from dry maize)





33.75 %
%
22
21
20
19
18
17
16
15
14
13
Moisture Content
molded
KNO3 (92. 6 RH%)
Figure 3
Changes of Moisture Content in Stored Maize at Various Humidity (start from wet maize)
KCl (84. 2 RH%)
molded
KBr (80. 8 RH%)
NaCl (75. 5 RH%)
KJ ((70. 2 RH%)
Week
0
1
3
5
7
9
11
Storing Period

III-1-(3)-5.
Studies on the Population of A. flavus and Aflatoxin Content in Ear Maize Stored With and Without Husk in the Farmer's Cribs.

Research Implementation Plan:
1. Analysis of contamination factors.
(3). Correlatin between cultural practices and aflatoxin contamination.
Code No. III-1-(3)-5 (1990).
Related Code No. I-1-(1) (1990).

Research Member:
Arunsri Wongurai, Prawat Tan Boon-ek (DoA).
Teruhiko Nibe, Katsusuke Arai (JICA).

Summary:
The microbe and Agronomy groups jointly carried out the studies on the effect of husk of maize, with or without, to avoid A. flavus and aflatoxin contamination for extend storing period in farmer's cribs. The Microbe group has been studied on the population of A. flavus and aflatoxin content during storing. The Agronomy group has been done measuring moisture content of maize, temperature and carbon dioxide gas concentration of inside pile of ear, temperature and humidity in the cribs. The protective effect of husk of maize from A. flavus and aflatoxin contamination was found. Generally, A. flavus population in maize with husk was lower than that of without husk. Clear differences of aflatoxin content were found between maize with and without husk. Aflatoxin content in maize with husk is lower than that of without husk. Some differences of A. flavus infection and aflatoxin content were observed among three cribs which may be due to the crib structure.

Achivement: 80 %

Problems remained:
Making improved cribs (3 cribs) and repeat experiment same way in 1990.

III-1-(3)-6.
A. flavus Infection and Contamination in the Maize Field.

Research Implementation Plan:
1. Analysis of contamination factors.
(3). Characteristics of A. flavus relating aflatoxin contamination.
Code No. III-1-(3)-6 (1990~91).

Research Member:
Prisnar Siriacha, Prawat Tan Boon-ek (DoA).
Katsusuke Arai (JICA).

Summary:
A. flavus infection and contamination route on maize are not well studied in Thailand. In the previous work in 1989, considerable A. flavus infection and contamination on the part of maize plant were observed. Also, A. flavus contamination in shelled maize kernel was increased as compared to before shelling.
Hence, this subject was continued to reconfirm the fact that observed in last year.
Maize was planted in the test field of Phraputtabat Field Crops Experiment Station on 15th June, 1990. Leaf, stem, tassel, silk, husk, cob and kernel were taken and plated on agar media to examine A. flavus infection for 10 times from after planting until harvest. Silk contamination and infection may lead A. flavus to contaminate kernel inside the cob, remain on the surface and ready to infect the kernel in favorable condition. Number of kernels infected with A. flavus were much higher than those from the cobs. This indicated that even A. flavus might be able to colonized maize kernel by way of silks, kernels were damaged by other factors, such as insect.

Achivement: 80 %

Problems remained:
Reconfirm the contamination route through silk.
Insect damage might be major contamination route.

III-1-(3)-7.
Identification of Aflatoxin Producing Ability of A. flavus by Coconut Powder and Coconut Cream Agar.

Research Implementation Plan:
1. Analysis of contamination factors.
(3). Characteristics of A. flavus relating aflatoxin contamination.
Code No. III-1-(3)-7 (1990).

Research Member:
Arunsri Wongurai, Prawat Tan Boon-ek (DoA).
Michihiko Saito, Katsusuke Arai (JICA).

Summary:
To develop new identification method for aflatoxin producing ability of A. flavus, both coconut powder and coconut cream agar were tested to the strains isolated from maize, soil and air. Selected 12 of A. flavus strains known aflatoxin producing ability determined by TLC method were used for the experiment. Three non aflatoxin producing strains of A. flavus and one low type did not show any fluorecesnt under the UV light, 365 nm. Six aflatoxin producing strains showed fluorescent more or less. However, there were two exceptions in aflatoxin producing type. Some differences in fluorescent color were observed among A. flavus strains, especially G1 producing type showed bright fluorescent color.

Achivement: 80 %

Problems remained:
Test should be continued for a large number of A. flavus strains known aflatoxin producing ability.
Apply to another mycotoxin producing fungi.

III-1-(3)-8.
Studies on A. flavus Infection and Aflatoxin Contamination During Sun Dry in the Laboratory and Middleman Scale.

Research Implementation Plan:
1. Analysis of contamination factors.
(3). Characteristics of A. flavus relating aflatoxin contamination.
Code No. III-1-(3)-8 (1990).

Research Member:
Suparat Kositcharoenkul, Kanjana Bhudhasamai, Prawat Tan Boon-ek (DoA).
Michihiko Saito, Katsusuke Arai (JICA).

Summary:
Thai maize is mainly cultivated and harvested in rany season. Drying of maize is usually accomplished in the sun. Therefore, once rain comes, drying has to be stopped and undried maize is heaped up on the drying yard covered with tarpaulin to wait recover. If the maize contains high moisture content, mold might be grown not only surface but also inside tissure of maize kernels even overnight. Hence, Microbe group has planned to investigate the changes of A. flavus and aflatoxin contamination in actual condition of sun dry of maize at middleman level and effect of various thickness of maize by laboratory scale on the drying floor in the sun.
Sun dry experiment has been carried out on 4 duplicate in the middleman and laboratory scale in 1990 maize season at Phraputtabat, Lop Buri. The purpose of experiment was: 1) to know the influence of thickness and initial moisture content of maize for sun drying, 2) to know the changes of A. flavus contamination and aflatoxin content during sun drying. Weather condition in the 1st and 2nd experiments was quite fair and drying was accomplished in a short time. In 3rd and 4th experiments, drying was interrupted for 2 or 3 times during that period due to unfavorable thunder storm and it took more than 4 days to finish the drying. There was no or little increase of A. flavus infection and aflatoxin contamination in the 1st and 2nd experiment in both laboratory scale and middleman scale. However, in the 3rd and 4th experiments, little increase of A. flavus infection was observed, but aflatoxin contamination was not so clear. It is understood that aflatoxin content in maize at initial stage of sun drying will affect on the amount in final product.

Achivement: 80 %

Problems remained:
Catch up the reason of fructuations of A. flavus population and aflatoxin content during sun drying experiment (sampling error or experiment error ?).
Influence of sun shine on aflatoxin content in maize.
Measure the accumulated solar energy during sun drying.

III-2-(1)-A & B.

Aflatoxin Content in Stored Maize Determined by Immunoassey (ELISA).

Research Implementation Plan:
2. Improvement of test techniques.
(1). Improvement of simple and rapid analytical method of aflatoxin.
Code No. III-2-(1)-A & B (1989).

Research Member:

Suparat Kositcharoenkul, Prawat Tan Boon-ek (DoA).
Tetsuhisa Goto, Katsusuke Arai (JICA).

Summary:

This subject was carried out as one of improvement of technique for aflatoxin analysis.
Newly developed analytical method for aflatoxin, ELISA using monoclonal antibody with high specifity against aflatoxin B1 (UBE EIA KIT-AFB1, product of Ube Kosan Co. Ltd., Japan) was hired to stored maize samples. It is recognized that ELISA is rapid analytical method and has high sensitivity for AFB1. However, it needs skilled person and some special equipment, for instance, micro-plate reader, special type of pipett etc., also the price of the kit is expensive.
In this experiment, relations between BGYF (Bright Greenish Yellow Fluorescent) and Aflatoxin B1 content in maize samples were also studied. However, clear, high correlation was not found.

Achivement: 90 %

Problems remained:
It need to prepare the ELISA in the laboratory.

III-2-(1)-C.
Improvement of the Mini-column Method for the Aflatoxin Content in Maize.

Research Implementation Plan:
2. Improvement of test techniques.
(1). Improvement of simple and rapid analytical method of aflatoxin.
Code No. III-2-(1)-C (1990).

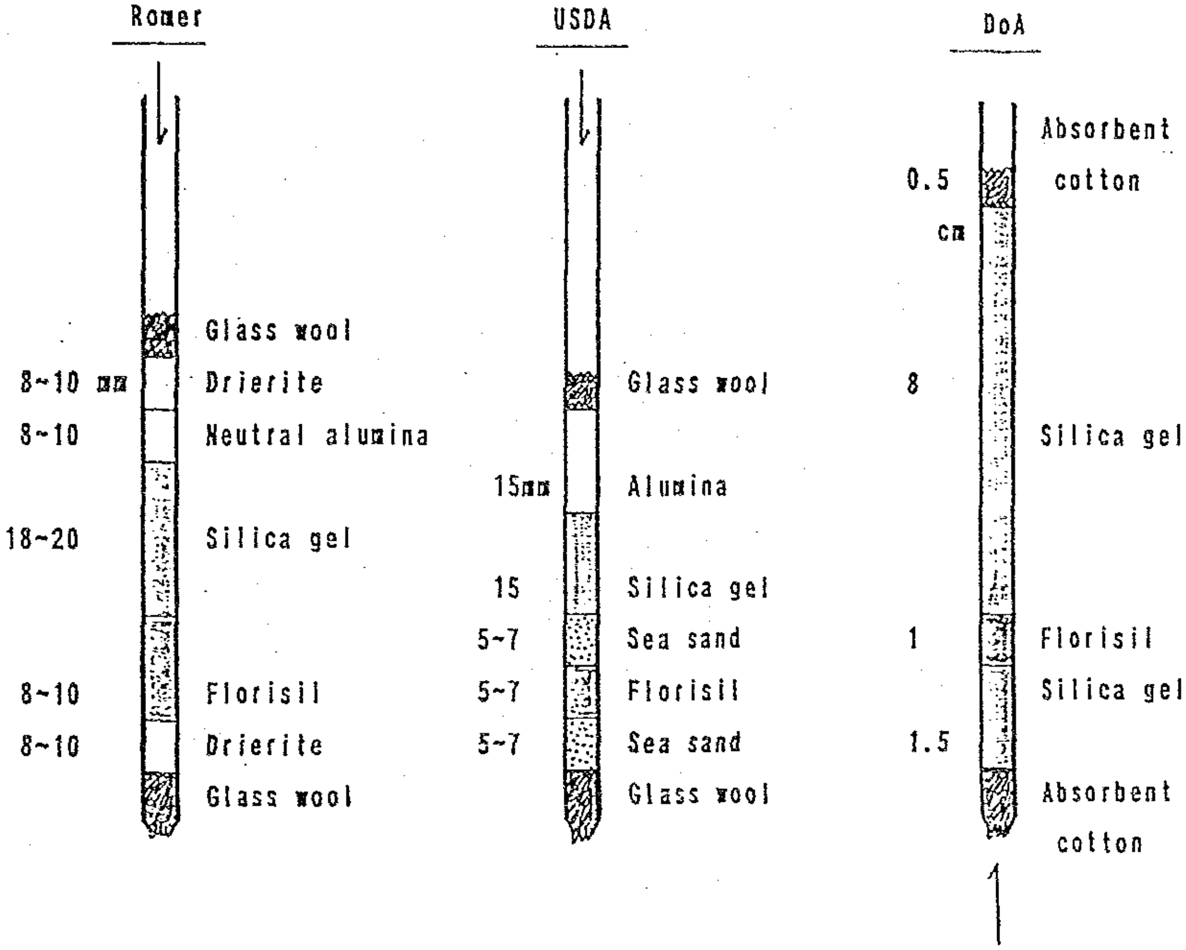
Research Member:
Suparat Kositcharoenkul, Prawat Tan Boon-ek (DoA).
Toshitsugu Tanaka, Katsusuke Arai (JICA).

Summary:
There are some accurate analytical method for aflatoxin using Hi-Tec instruments, such as HPLC or TLC, but they are expensive, required skilled people and also time consuming.
The Holaday-Velasco and Romer minicolumn methods are recommended as Official Analytical Method by AOAC. The principle of minicolumn method is the column chromatography using several absorbent and dehydrating agent. However, these methods require the some special chemicals and lab-wears. Hence, we tried modification of the method to save the chemicals, glasswears and time consuming for detection.
Modified mini-column method packed with silica gel, Florisil and silica gel in 3 layers to detect aflatoxin in maize was developed. The mini-column (ID 4mm × H 15cm) was packed with 1.5cm of silica gel, followed by 1cm of Florisil and 8.5cm of silica gel. Fifty grams of ground maize sample was extracted with chloroform-methanol (97:3) using ultra-sonicator in a beaker. After extraction, a thimble filter paper was put into the beaker for filtration, and mini-column was inserted to the extract, then developed to the top of column. After developing, fluorescent band appeared on the Florisil layer was observed under the 365nm UV light. The detection limit of the modified method employed was 10ng (ppb) for aflatoxin B1 or mixtures. It is applicable for screening of aflatoxin in maize.

Achivement: 90 %

Problems remained:
Standardize the fluorescent intensity of the modified mini-column compared with a large number of maize samples known aflatoxin content.
Try using photometer to measure the fluorescent intensity.
Feasibility test of the mini-column for other mycotoxin, e.g. zeararenon, deoxynivarenol etc.
Making and diffuse the mini-column kit (wether approved or not by concerned people)

Comparison of Minicolumns



Aflatoxin Analysis in Maize
by Modified Minicolumn Method

Weigh 50 gm of
ground sample
to 300 ml beaker
(pass 100 mesh)

|

Extract with
100 ml of
$CHCl_3$: MeOH
(97 : 3)

|

Filter by thimble
filter paper

|

Put the minicolumn
into the filtrate

|

Develop
for 20 min.

|

Observe
fluorescent band
on the Florisil layer
under the UV-light
(365 nm)

Preparation of Spiked Aflatoxin B_1 in Maize Sample

	Maize	AFB_1	AFB_1 1 ng/g	AFB_1 Conc.
1.	50 gm	500 ng	0.5 ng/g	10 ppb
2.	"	1000 "	1.0 "	20 "
3.	"	1500 "	1.5 "	30 "
4.	"	2000 "	2.0 "	40 "
5.	"	2500 "	2.5 "	50 "
6.	"	5000 "	5.0 "	100 "

Detection Limit of Aflatoxin B_1 (ng/g)

	Column	Aflatoxin B_1 Spiked (ng/g)						
Absorbent	ID cm	0	10	20	30	40	50	100
Silica G.	3	-	+	+	++	++	+++	++++
(1.5 cm)	4	-	+	+	++	++	+++	++++
	5	-	+	/	/	/	/	/
Alumina	3	-	+	+	++	++	+++	++++
(4 cm)	4	-	+	+	++	++	+++	++++
	5	-	+	+	++	++	/	/

Preparation of Spiked Aflatoxin $B_1 \sim G_2$ in Maize Sample and Minicolumn Score

	Spiked AF	Total AF	Minicolumn score
1.	B_1 only 5 ng/g	5 ng/g	+
2.	10	10	+
3.	20	20	++
4.	30	30	+++
5.	B_1 5 ng/g & B_2 0.5 ng/g	5.5 ng/g	+
6.	10 & 1	11	+
7.	20 & 2	22	++
8.	30 & 3	33	++
9.	B_1 2 ng/g & B_2 0.5 ng/g G_1 2 & G_2 0.5	5 ng/g	+
10.	B_1 5 & B_2 0.5 G_1 5 & G_2 0.5	11	++
11.	B_1 10 & B_2 1 G_1 10 & G_2 1	22	+++
12.	B_1 15 & B_2 1.5 G_1 15 & G_2 1.5	33	++++

Recovery of AF in Maize Samples Determined using HPLC
by Various Extraction Method

Sample	Shaker		Ultra-Sonicator		
		ppb		ppb	
L_{2-2}	ND		B1	3	
L_{9-8}	B_1	60	B_1	45	(75%)*
	B_2	5	B_2	4	
L_{3-5}	B_1	56	B_1	35	(63%)
	B_2	3.5	B_2	-	
D_{8-15}	B_1	143	B_1	82	(57%)
	B_2	7.4	B_2	5	
D_{3-6}	B_1	130	B_1	84.5	(65%)
	B_2	7.2	B_2	5	
	G_1	0.15	G_1	-	
D_{7-12}	B_1	388.4	B_1	209	(54%)
	B_2	0.4	B_2	0.22	
D_{8-9}	B_1	527.5	B_1	340.1	(65%)
	B_2	87.9	B_2	18.6	

solvent : $CHCl_3/H_2O$ (250 : 25)

* precent against shaker extraction

Comparison of AF Content in Maize Samples
Determined by HPLC and DoA Minicolumn

Sample	AF ppb (HPLC)		Total AF ppb (DoA Minicolumn*)	
			Person A	Person B
L_{11-4}	B_1	820	>>> 100	>> 100
	B_2	40		
	G_1	0.85		
L_{6-4}	B_1	73	>> 50	>> 50
L_{8-5}	B_1	34	≒ 50	≒ 50
L_{9-2}	B_1	41	20~50	20~50
L_{3-6}	B_1	22.9	> 50	20~50
	G_1	0.1		

* Ratio of absorbent :
Silica G.(1.5)/Florisil (1)/Silica G.(8) in cm
from bottom to top

III-3-(3)-A.

Studies on the Effect of Ammonia Treatment for Prevension of Fungus Invasion to Ear and Grain Maize.

Research Implementation Plan:
3. Countermeasure of aflatoxin prevention.
(3). Aflatoxin prevention by controlling A. flavus.
Code No. III-3-(3)-A (1988).
Related Code No. II-3-(2).

Research Member:
Arunsri Wongurai, Chaiwat Paosantadpanich, Prawat Tan Boon-ek, Siriwai Singhagajen (DoA).
Osamu Tsuruta Katsusuke Arai, Mikio Kamo, Makoto Kobayashi (JICA).

Summary:
The purpose of this study is to know the feasibility of suppresion power of ammonia applied for high moisture content of maize to extend storing period before drying.
The study was carried as a joint research work with both Microbe and Post-harvest groups in 1988 maize crop season. The ammonia treatment was made by Post-harvest group and aflatoxin analysis and microbiological experiment were carried out by the Microbe group.
Though the experiments showed some fructuations of fungi multiplication and aflatoxin content, it is recognized that the ammonia has some effect to control growth of A. flavus and aflatoxin contamination in early stage of the storing after the treatment, but glossy golden color of maize was disappeared and turned to dark color, release unusual smell even in low ammonoia concentration.

Achivement: 70 %

Problems remained:
Biggest problem is discoloration of maize caused by ammonia.
It is necessary to know the safeness, nutritive value and commodity value in both domestic and international trading, even if A. flavus could not grow and not detected aflatoxin by ammonia treatment for maize.
Also, it is important to evaluate the economic returns of using chemicals and subsidery materials to extend storing period of freshly harvested maize.
Select more moderate chemicals.

III-3-(3)-B-1.
Control of A. flavus and Aflatoxin Contamination of High Moisture Content Maize in Anaerobic Condition.

Research Implementation Plan:
3. Countermeasure of aflatoxin prevention.
(3). Aflatoxin prevention by controlling A. flavus.
Code No. III-3-(3)-B-1 (1990).

Research Member:
Prisnar Siriacha, Surang Suthirawut, Prawat Tan Boon-ek (DoA).
Katsusuke Arai (JICA).

Summary:
Thai maize is mainly cultivated and harvested in rainy season. Moisture content of maize just harvested is usually ranging from 25 to 35%. If middlemen accepted the fresh shelled maize beyond their drying capacity, drying will not be able to accomplish in a short time and maize might be contaminated by mold. To avoid such incidence, several treatment have been examined so far. TARC and MQIRC microbe group has found the fact that anaerobic condition in plastic bag has an effect to control growth of A. flavus especially high moisture maize.
In 1990 maize season, large scale experiment was attempted and examined microbiologically. Carbon dioxide gas concentration in the plastic bag was dramatically increased immediately after packed. By contrast, oxygen gas concentration was decreased at the same time. Total fungi in the samples in plastic bag was gradually decreased and reached to 3% within one week, and maintained same level for 4 weeks. A. flavus contamination was little increased from 0 to 10% within 2 days in early stage, then decreased to 1% level after 4 days. On the other hand, population of some lactic bacteria and yeast were increased during storage. Aflatoxin was not detected even 4 weeks stored maize. Nutrition value and safeness of maize stored in the plastic bag was tested by poultry with the Chicken Center of Kasetsat University. There was no problem for chicken raising.

Achivement: 90 %

Problems remained:
More large scale experiment like silo, some other container, box etc. have to be tried.
Experiment has to be applied to low moisture content maize, e. g. below 30~20%.
Gas composition in the bag should be analyzed by more accurate method, e. g. gas chromatograph.
Identify bacteria grown during anaerobic storing.

Fig 1 Oxygen and carbon dioxide in plastic bag 24 hours after storage (%)

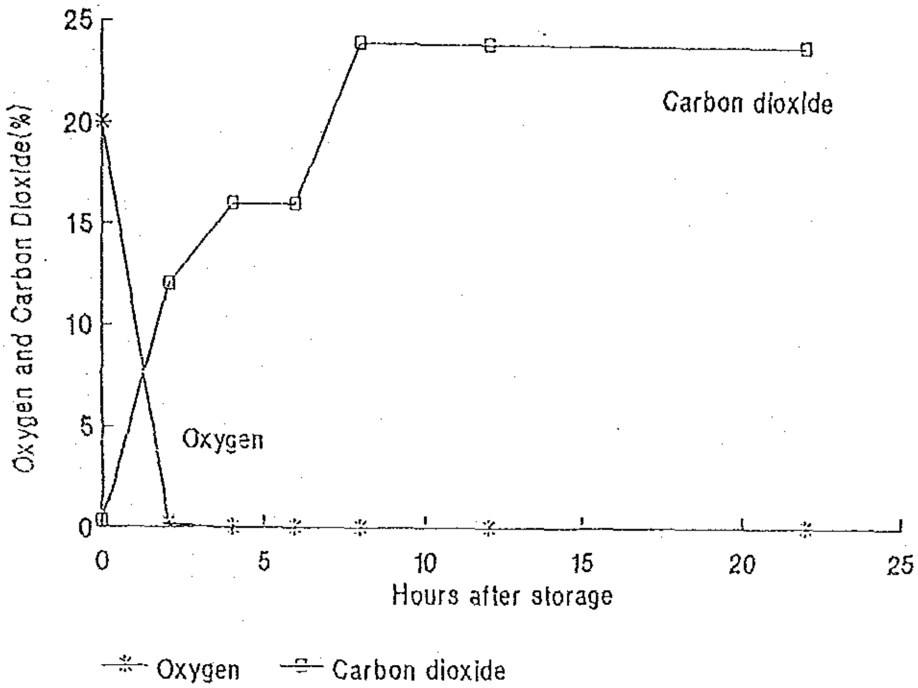


Fig 2 Oxygen and carbon dioxide in plastic Bag and jute bag during storage (%)

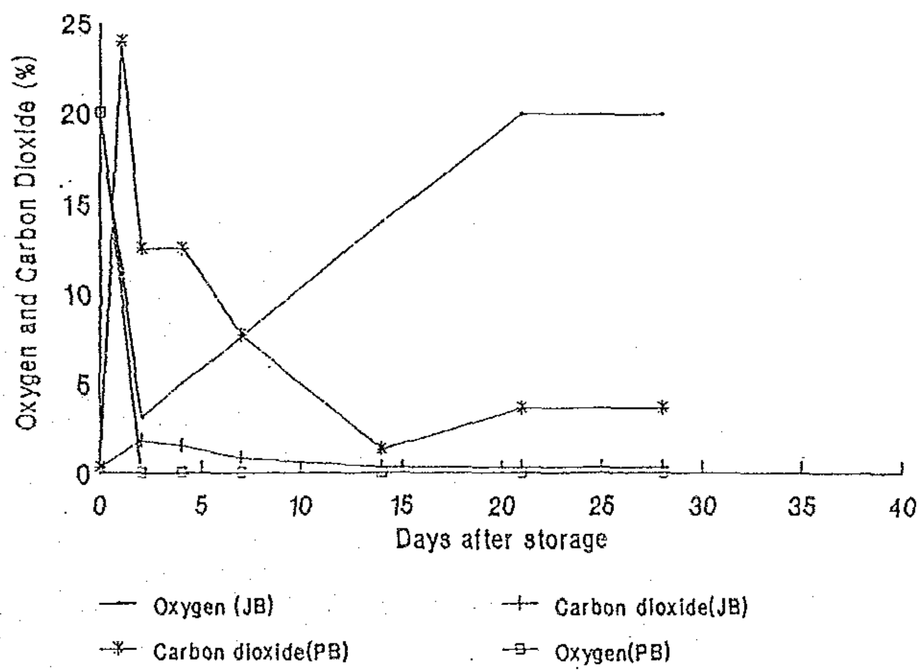


Fig 3 Infection of A. flavus and other fungi of maize in plastic bag and jute bag

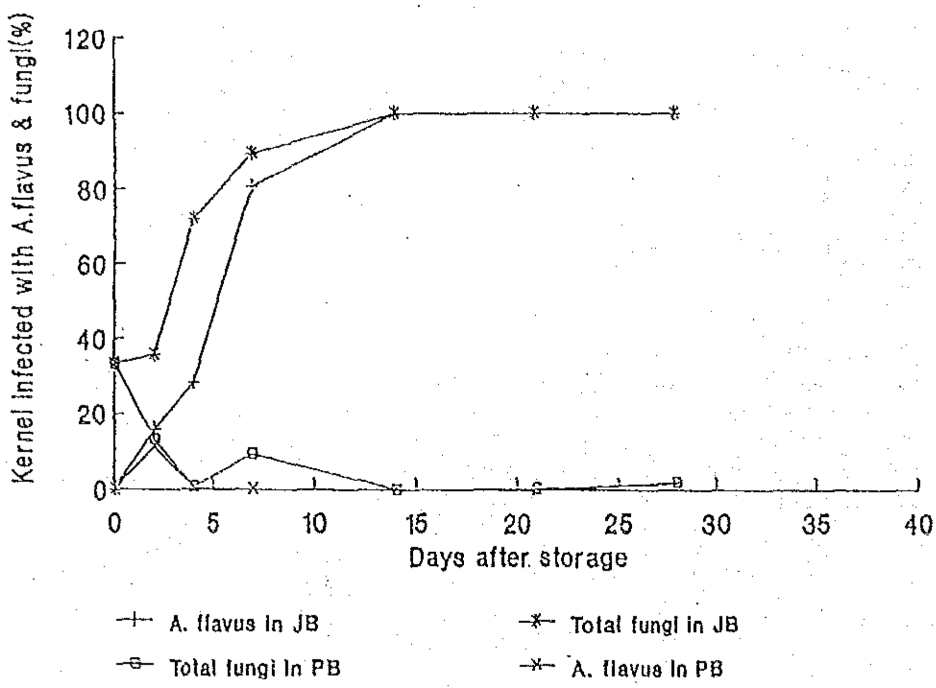


Table 1 Composition of the experimental rations

Ingredients	Percent in ration 0-4 wks	4-8 wks
Maize	54.520	63.400
Concentrate	15.000	14.000
Soybean oil meal (42-43 % prot.)	18.500	9.150
Fish meal (54 % prot.)	7.500	9.400
Vegetable oil	4.000	3.750
DL-methionine	0.480	0.200
Lysine	-	0.070
Vit. premix*	0.125	0.125
Min. premix*	0.0175	0.0175
Total	100.1430	100.1125

Composition, calculated :

	0-4 wks	4-8 wks
Metabolizable energy (kcal/kg diet)	3,100.00	3,200.00
Crude protein (%)	22.00	19.00
Lysine (%)	1.25	1.10
Methionine (%)	0.86	0.57
Methionine + Cystine (%)	1.21	0.88
Tryptophan (%)	0.25	0.21
Fat (%)	7.50	7.50
Crude fiber (%)	3.70	3.50
Calcium (%)	1.10	1.15
Total phosphorus (%)	0.75	0.75
Salt (%)	0.45	0.47

* Vitamin and mineral premixes were the mixtures used at the Poultry Research Farm, Department of Animal Science, Kasetsart University

Table 2 Temperature of maize in plastic bag and jute bag during storage

Temperature (°c) / Treatment	Days after storage 0	1	2	4	7	14	21	28
Plastic bag	35	33.5	33.5	32.8	30.5	29.5	30.0	30.5
jute bag	35	60	47.5	47.0	47.5	49.0	41.0	31.0

Table 3 Moisture content of maize in plastic bag and jute bag during storage

M.C. content (%) / Treatment	Days after storage 0	2	4	7	14	21	28
plastic bag	35.3	34.9	37.1	36.4	34.9	33.8	34.9
jute bag	35.3	33.8	33.2	25.5	18.8	17.5	18.6

Table 4 pH of maize in plastic bag and jute bag during storage

pH / Treatment	Days after storage 0	2	7	14	21	28
plastic bag	5.8	4.3	4.1	4.0	3.9	4.1
jute bag	5.8	5.5	6.1	6.1	6.2	6.1

Table 5 Aflatoxin in plastic bag and jute bag during storage

Aflatoxin (μg/1g) / Treatment	Days after storage 0	2	7	14	21	28
plastic bag	ND	ND	ND	ND	ND	ND
jute bag	ND	ND	13(B,)	14(B1)	150(B1) 11(B2)	61(B1) 7(B2)

Table 6 Proximate analyses of maizes packed in plastic bag differing in storaging times and commercial maize

Maize	Moisture %	Crude Protein %	Crude Fat %	Crude Fiber %	N.F.E. %	Ash %	Ca %	P %
0 days	9.95	8.22	4.79	1.37	74.08	1.37	0.12	0.10
7 days	10.26	8.40	3.52	1.89	73.22	1.72	0.65	0.34
14 days	9.00	9.12	4.36	1.50	74.06	1.40	0.37	0.19
21 days	8.51	9.86	4.95	1.32	73.19	1.53	0.41	0.23
28 days	7.95	8.18	4.88	1.47	75.16	1.59	0.49	0.28
Control	11.16	8.21	3.35	2.01	72.79	1.65	0.52	0.31

Table 7 Proximate analyses of experimental rations (day-old to 4 wks of age)

Treatments	Moisture %	Crude Protein %	Crude Fat %	Crude Fiber %	N.F.E. %	Ash %	Ca %	P %
0 days	9.25	22.26	6.62	4.82	74.08	5.97	1.22	0.69
7 days	9.67	21.54	7.39	4.81	73.22	5.83	1.19	0.67
14 days	8.87	22.00	7.16	4.57	74.06	6.03	1.23	0.71
21 days	8.66	22.24	7.44	4.13	73.19	6.16	1.29	0.73
28 days	8.20	22.92	7.43	4.66	75.16	5.94	1.24	0.71
Control	9.99	20.70	6.96	5.12	72.79	5.81	1.25	0.66

Table 8 Proximate analyses of experimental rations (4 to 8 wks of age)

Treatments	Moisture %	Crude Protein %	Crude Fat %	Crude Fiber %	N.F.E. %	Ash %	Ca %	P %
0 days	11.95	19.43	7.53	2.50	50.90	5.73	1.19	0.77
7 days	12.08	19.47	7.75	2.35	50.63	5.67	1.32	0.73
14 days	11.28	19.24	7.18	2.75	52.18	5.56	1.16	0.65
21 days	11.24	21.69	7.38	2.26	49.81	5.72	1.19	0.71
28 days	11.13	20.19	8.06	2.11	50.77	5.80	1.20	0.74
Control	12.59	18.12	6.53	2.82	52.00	5.98	1.27	0.69

Table 9 Growth performance of broilers fed differing maize preserved in various days (day-old to 2 wk of age)

Treatments	Body weight gain (kg) ± SE	Feed consumption (kg) ± SE	Feed conversion ratio ± SE	Feed efficiency ratio ± SE
1. 0-days maize	0.297 ± 0.0066	0.411 ± 0.0049	1.385 ± 0.0219	0.723 ± 0.0113
2. 7-days maize	0.297 ± 0.0076	0.406 ± 0.0061	1.368 ± 0.0321	0.733 ± 0.0171
3. 14-days maize	0.290 ± 0.0068	0.407 ± 0.0052	1.405 ± 0.0184	0.712 ± 0.0095
4. 21-days maize	0.294 ± 0.0055	0.401 ± 0.0062	1.367 ± 0.0072	0.732 ± 0.0039
5. 28-days maize	0.292 ± 0.0033	0.412 ± 0.0017	1.413 ± 0.0157	0.708 ± 0.0079
6. Control	0.293 ± 0.0045	0.410 ± 0.0054	1.400 ± 0.0113	0.715 ± 0.0057

Table 10 Growth performance of broilers fed differing maize preserved in various days (day-old to 4 wk of age)

Treatments	Body weight gain (kg) ± SE	Feed consumption (kg) ± SE	Feed conversion ratio ± SE	Feed efficiency ratio ± SE
1. 0-days maize	0.953 ± 0.0112	1.651 ± 0.0147^{ab}	1.733 ± 0.0104	0.577 ± 0.0035
2. 7-days maize	0.936 ± 0.0176	1.620 ± 0.0161^{abc}	1.732 ± 0.0226	0.578 ± 0.0076
3. 14-days maize	0.910 ± 0.0113	1.589 ± 0.0105^{bc}	1.748 ± 0.0280	0.573 ± 0.0093
4. 21-days maize	0.920 ± 0.0123	1.567 ± 0.0181^{c}	1.704 ± 0.0186	0.587 ± 0.0063
5. 28-days maize	0.952 ± 0.0212	1.626 ± 0.0254^{abc}	1.710 ± 0.0127	0.585 ± 0.0043
6. Control	0.947 ± 0.0268	1.670 ± 0.0277^{a}	1.767 ± 0.0311	0.567 ± 0.0097

Means not sharing a common superscript letter within the same column are significantly different at $P < 0.05$.

Table 11 Growth performance of broilers fed differing maize preserved in various days (day-old to 6 wk of age)

Treatments	Body weight gain (kg) ± SE	Feed consumption (kg) ± SE	Feed conversion ratio ± SE	Feed efficiency ratio ± SE
1 0-days maize	1.688 ± 0.0258	3.272 ± 0.0463^{a}	1.939 ± 0.0160^{a}	0.516 ± 0.0043^{c}
2. 7-days maize	1.648 ± 0.0411	3.128 ± 0.0741^{abc}	1.899 ± 0.0075^{ab}	0.527 ± 0.0021^{bc}
3. 14-days maize	1.609 ± 0.0223	3.026 ± 0.0612^{bc}	1.881 ± 0.0151^{bc}	0.532 ± 0.0043^{ab}
4. 21-days maize	1.615 ± 0.0291	2.978 ± 0.0488^{c}	1.845 ± 0.0109^{c}	0.542 ± 0.0032^{a}
5. 28-days maize	1.639 ± 0.0229	3.122 ± 0.0607^{abc}	1.905 ± 0.0119^{ab}	0.525 ± 0.0033^{bc}
6. Control	1.659 ± 0.0218	3.206 ± 0.0587^{ab}	1.933 ± 0.0221^{a}	0.518 ± 0.0059^{c}

Means not sharing a common superscript letter within the same column are significantly different at $P < 0.05$.

Table 12 Growth performance of broilers fed differing maize preserved in various days (day-old to 8 wk of age)

Treatments	Body weight gain (kg) ± SE	Feed consumption (kg) ± SE	Feed conversion ratio ± SE	Feed efficiency ratio ± SE
1 0-days maize	2.204 ± 0.0222	4.700 ± 0.0646^{a}	2.133 ± 0.0220	0.468 ± 0.0048
2. 7-days maize	2.135 ± 0.0672	4.532 ± 0.1003^{ab}	2.125 ± 0.0245	0.471 ± 0.0060
3. 14-days maize	2.190 ± 0.0506	4.463 ± 0.0752^{ab}	2.040 ± 0.0428	0.491 ± 0.0100
4. 21-days maize	2.150 ± 0.0307	4.369 ± 0.1126^{b}	2.032 ± 0.0375	0.493 ± 0.0094
5. 28-days maize	2.164 ± 0.0404	4.497 ± 0.0660^{ab}	2.079 ± 0.0239	0.481 ± 0.0055
6. Control	2.159 ± 0.0549	4.580 ± 0.0289^{ab}	2.126 ± 0.0539	0.471 ± 0.0123

Means not sharing a common superscript letter within the same column are significantly different at $P < 0.05$.

III-3-(3)-B-4.

Population Dynamic of Microorganism Involved in Maize Stored in Anaerobic Condition.

Research Implementation Plan:
3. Countermeasure of aflatoxin prevention.
(3). Aflatoxin prevention by controlling A. flavus.
Code No. III-3-(3)-B-4 (1990~91).

Research Member:
Suran Suthirawut, Prisnar Siriacha, Prawat Tan Boon-ek (DoA).
Katsusuke Arai (JICA).

Summary:
High moisture content maize were kept in anaerobic condition in plastic bag for 2 months. Twenty-five gram of maize sample was collected at period of 0, 2, 4, 7, 21, and 28 days, 5 weeks, 6 wks, 7 wks. and 8 wks., and examined bacteria, fungi and yeast. Not only growth of A. flavus but also other fungi were inhibited within 2 days to 6 wks. Dominant microorganisms were gram positive cocci, catalase + or -, facultative anaerobe and anaerobic bacteria. All of them could produce lactic acid on GYCA. Due to the effect of these microorganism, pH of sample was changed from 6 to 4. Population of total bacteria was increased from 10^5 CFU/gm to 10^8 within 7 days and gradually decreased to 10^5 within 8 wks. During period of 4 to 8 wks., one type of yeast was found. No human pathogenic bacteria was detected.

Achivement: 80 %

Problems remained:
Identify bacteria and yeast inorder to improve the quality of maize. Find the minimum level of moisture content which can be kept in anaerobic condition in plastic bag.

Table 1 Bacterial population, fungal growth and pH examination on maize storaged by Polyethylene bag and jute bag (control).

Storage time	Polyethylene bag					control	
	Bacterial Population (cfu/gm)			pH	Fungal growth on SPC	pH	Fungal Growth on SPC
	SPC	YM a)	GYCA				
0 d	4.8×10^{6}	3.2×10^{6}	5.9×10^{5}	5.8	+	5.8	+b)
2 d	8.0×10^{7}	1.8×10^{7}	9.3×10^{7}	4.3	-	5.5	+b)
4 d	6.7×10^{7}	3.0×10^{7}	7.6×10^{7}	4.1	-	6.1	+b)
7 d	1.7×10^{8}	3.2×10^{7}	1.0×10^{8}	4.0	-	6.1	+
14 d	3.6×10^{7}	2.2×10^{7}	3.6×10^{7}	4.0	-	6.2	+
21 d	NDc)	ND	ND	3.9	-	6.3	+
28 d	5.0×10^{6}	2.2×10^{6}	2.8×10^{6}	4.1	-	6.1	+
5 wk	3.9×10^{6}	3.8×10^{6}	2.1×10^{6}	3.9	-	5.7	+b)
6 wk	3.0×10^{6}	2.5×10^{6}	2.3×10^{6}	4.1	-	6.0	+b)
7 wk	4.8×10^{6}	3.2×10^{6}	2.0×10^{6}	4.1	+	6.2	+b)
8 wk	2.3×10^{5}	2.3×10^{6}	1.7×10^{5}	4.2	+	6.5	+b)

Remark : a) Population of 2 kind of lactic acid bacteria and yeast. Only yeast was found on the maize storaged from 28 d to 8 wk.

b) Population of fungi and bacteria was determined.

c) ND = not determined.

Table 2 Approximately percentage of different kinds of microorganism found on YM Agar at different storage time.

Storage time	Bacteria			Yeast [c]
	Y 38 1[a]	Y 38 2[b]	others	
od	ND[d]	ND	ND	0
2d	80	18–20	0–2	0
4,7,14 d	90	5–10	3–5	0
21d	95	5	0	0
28d	80	2	0	15–20
5 wk	90–95	0–1	0	5
6 wk	70–80	15–20	0	1–2
7 wk	70–80	15–20	0	1–2
8 wk	70–80	15–20	0	1–2

Remark : a) circular , convexed , creamish white , diameter 1–2 mm

b) circular , raised , yellowish cream , diameter 1.5–2 mm

c) Only one kind of yeast was found.

d) ND = not determined.

④ 延長要請書

Form P.

Request for New Technical Assistance Project

(Please read attached instruction before completing the request)

Project Title The Maize Quality Improvement Research Centre Project

Requesting agency : Department of Agriculture (DOA)

Ministry of Agriculture and Cooperatives (MOAC)

Proposed Source (s) of Assistance Japan International Cooperation Agency (JICA)

---

1. Background information and justification for the project

The Record of Discussion of the Maize Quality Improvement Research Centre Project (MQIRC) was signed on 15th December 1986 between JICA, DOA and DTEC as mentioned in the attached document.

The research studies of how to control and finding the control measures methodologies on aflatoxin of corn through the channel of agronomy, microbe, post harvest technologies are the main aim of the project.

2. Details of the project

2.1 Program goal (or sector goal)

To prevent and control aflatoxin of corn in Thailand.

2.2 Project objective

To transfer the appropriate control measures of how to prevent and control aflatoxin of corn both in the field and the storage to the persons and agencies concerned.

2.3 Conditions expected at completion of project (or end of project status)

The farmers and the exporter accept the appropriate control measures technologies on aflatoxin of corn from the project.

2.4 Recommended source (s) of information and data related to the project, necessary for project verification

The annual report of the project (the attached document 2.4)

2.5 Duration of the project : Starting (Requested for one year extension only)

From 15 December (month) 1986 (year)

To 14 December (month) 1992 (year)

2.6 Project site (s)

Administration	- The Maize Quality Improvement Research Centre (MQIRC), Department of Agriculture, Bangkhen, Bangkok
Agronomy	- Phra Phutthabat Field Crops Experiment Station, Lopburi, farmer fields and private sectors
Microbiology	- MQIRC, farmer fields, storage of private sectors
Post harvest	- MQIRC and Agricultural Machinary Workshop Site at Klong Laung, Prathumthani Some activities are involved with exporters, Department of Livestock, Universities. etc.

2.7 Project work plan and activities

2.7.1 Detail of work plan for MQIRC Project Extension

(15 December 1991 - 14 December 1992)

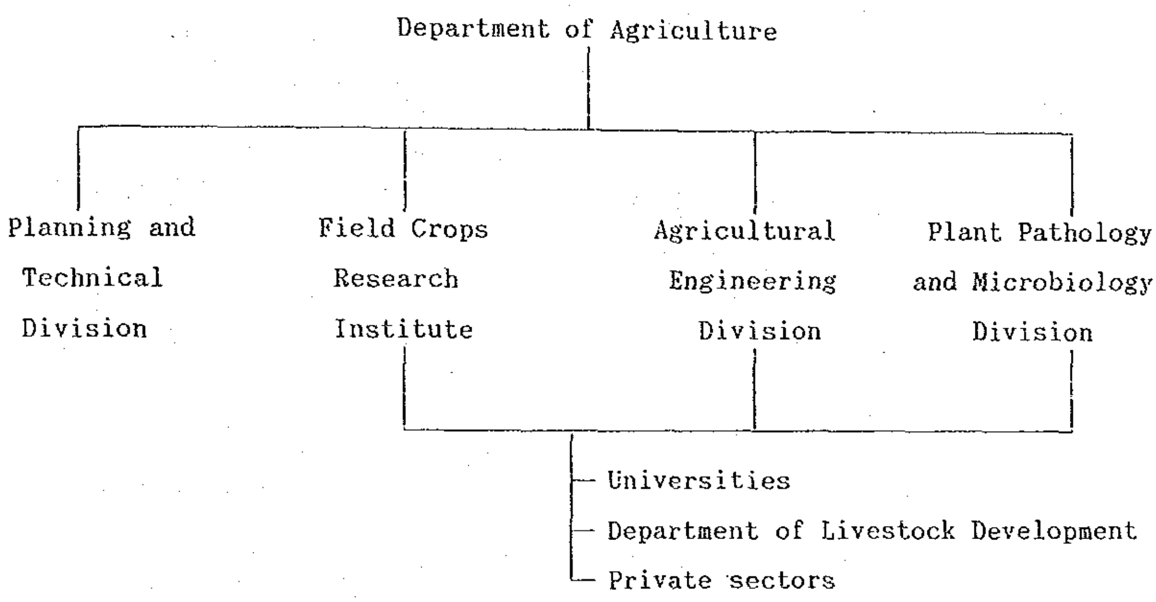
2.7.2 Time schedule of project activities (Please illustrate by showing time tables, figures, diagrams, etc.)

Activities	Dec. 1991	J	F	M	Apr	May	June	July	Aug	S	O	N	Dec. 1992
1. Research Work													
FCRI	—	—	—	—	—	—	—	—	—	—	—		
AED	—	—	—	—				—	—	—			
PPMD	—	—	—	—	—	—	—	—	—				
2. Sample Analysis													
FCRI		—	—	—	—	—				—	—		
AED		—	—	—	—	—							
PPMD	—	—	—	—	—	—	—	—	—	—	—		
3. Data Analysis													
FCRI				—	—	—	—		—	—	—		
AED		—	—	—	—	—	—		—	—	—		
PPMD									—	—	—		
4. Annual Report													
FCRI				—	—	—	—	—			—	—	
AED				—	—	—	—	—					
PPMD									—	—	—	—	
PTD													
5. Implementation of Final Report													
FCRI						—	—	—	—	—	—	—	—
AED							—	—	—	—	—	—	—
PPMD									—	—	—	—	—
PTD													

Note : FCRI = Field Crops Research Institute
AED = Agricultural Engineering Division
PPMD = Plant Pathology and Microbiology Division
PTD = Planning and Technical Division

3. Details of the implementing / operating agency

3.1 Institutional framework (including coordination with other agencies concerned)



3.2 Staff / personnel participating in project implementation (i.e. number, qualification, availability etc.)

Working Group (Permanent Officer)

MR.TANONGCHIT WONGSIRI
PROJECT DIRECTOR
(DIRECTOR GENERAL)

MR.SEIICHI UEDA
TEAM LEADER

MR.ANAN VATTANATANGUM
ASSISTANT PROJECT DIRECTOR
(DIRECTOR OF PLANNING AND
TECHNICAL DIVISION)

ADMINISTRATION SECTION

- MR.ANAN VATTANATANGUM
  (DIRECTOR OF PLANNING AND TECHNICAL DIVISION)
- MR.VIJAI NOP-AMORNBODI
  (SENIOR RESEARCHER, CHIEF OF THE SECTION)
- MRS.SIRIPORN SINDHUSAKE
  (RESEARCHER)
- MRS.SARANYA BUSPAROEK
  (RESEARCHER)
- MRS.BOONLUCK SEETANUN
  (RESEARCHER)
- MRS.PERMPOON SARNTHOY
  (RESEARCHER)
- MR.TAKEJI SEINO
  (JAPANESE PROJECT COORDINATOR)
- MRS.SUNTHREE NIAMGRUM
  (CLERK)

POST-HARVEST SECTION

- MR.CHAK CHAKKAPHAK
  (DIRECTOR OF AGRICULTURAL ENGINEERING DIVISION)
- MRS.SRIMAI SINGHAGAJEN
  (SENIOR RESEARCHER, CHIEF OF THE SECTION)
- MR.MITRI NAEWBANIJ
  (ENGINEER)
- MR.MITAT TANGPINIJKUL
  (ENGINEER)
- MR.PIMOL MUTISIN
  (ENGINEER)
- MR.MITSUHISA HARADA
  (JAPANESE POST-HARVEST EXPERT)
- MR.CHAIWAT PAOSANTADPANICH
  (ENGINEER)

AGRONOMY SECTION

- MR.VICHITR BENJASIL
  (DIRECTOR OF FIELD CROPS RESEARCH INSTITUTE)
- MR.NARONGSAK SENANARONG
  (SENIOR RESEARCHER, CHIEF OF THE SECTION)
- MR.AMNUAY TONGDEE
  (DIRECTOR OF NAKHONSAWAN FIELD CROPS RESEARCH CENTER)
- MR.AMNART CHINCHEST
  (DIRECTOR OF PHRA PHUTTHABAT FIELD CROPS EXPERIMENT STATION)
- MR.PRASOP DEBYASUVARN
  (RESEARCHER)
- MR.TERUHIKO NIBE
  (JAPANESE FIELD CROPS EXPERT)
- MR.SUKAPONG MAYUPAP
  (RESEARCHER)
- MR.VERAWAT MILRATTANAKOON
  (RESEARCHER)

MICROBE SECTION

- MRS.DARA BUANGSUWAN
  (DIRECTOR OF PLANT PATHOLOGY AND MICROBIOLOGY DIVISION)
- MR.PRAWAT TAN BOON-EK
  (SENIOR RESEARCHER, CHIEF OF THE SECTION)
- MRS.KANJANA BHUGHASAWAI
  (RESEARCHER)
- MR.KATSUSUKE ARAI
  (JAPANESE MICROBIOLOGICAL EXPERT)
- MISS ARUNSRI WONGURAI
  (RESEARCHER)
- MR.SUPARAT KOSITCHAROENKUL
  (RESEARCHER)
- MRS.PRISNAR SIRIACHA
  (RESEARCHER)
- MRS.SURANG SUTHIRAWAT
  (RESEARCH)
- MRS.MARUNEE PREMANOCH
  (RESEARCHER)

4. Assistance requested

4.1 Expert (long term)

Field of operation/activity	Total		1991		1992	
	No.	m/m	No.	m/m	No.	m/m
(1) Project Leader	1	12	1	0.5	1	11.5
(2) Project Coordinator	1	12	1	0.5	1	11.5
(3) Agronomy Expert	1	12	1	0.5	1	11.5
(4) Microbe Expert	1	12	1	0.5	1	11.5
(5) Post Harvest Expert	1	12	1	0.5	1	11.5

The requested for short term experts in necessary field will be done by agreed upon between DOA and JICA Staff.

FIELD CROPS RESEARCH INSTITUTE

Agronomy Group

Research plan

1991 maize cropping season

1. Research work in 1991 cropping season will continue/complete March 1991
2. Extraction of sample for aflatoxin will completed in mid April
3. Summary and conclusion of the 1991 result and the Project summary reporting will be made by June 1992

1992 maize cropping season

1. Some of the subjects required to repeat to confirm the result obtained previous years.
2. Some of the subject, such as harvesting and storage method, are necessary to confirm at real size or real situation to build up complete package or system for recommending the technology to farmer.

3. Some other, such as maize production simulation model or insect appearance and damage need continuous data accumulation for input for the model.

4. Extraction for aflatoxin analysis will be made starting from initial harvest season August to September. Then some subject will be kept in storage for two months.

AGRICULTURAL ENGINEERING DIVISION

Postharvest Group

Details of research work plan of Post-Harvest Group for one year extension are as follows :

1. Research works in laboratory
   1) Research works : (July 1991 - Mar. 1992)
      a) Drying method : (Aug. 1991 - Jan. 1992)
         - To fabricate dryer for farmers' storage and to test at the center.
      b) Storage facilities : (Sept. 1991 - Mar. 1992)
         - To fabricate modified storage for farmers and to conduct storing experiment.
      c) Corn sheller : (July 1991 - Jan. 1992)
         - To fabricate an improved corn sheller and to test efficiency
      d) Moisture meter : (Sept. 1991 - Jan. 1992)
         - To fabricate ear maize moisture meter and to calibrate it.
      e) Standardization of oven method : (Aug. 1991 - Dec. 1991)
         - To test several oven methods for moisture content determination to standardize Thai oven method.
   2) Sample analysis : (Sept. 1991 - May 1992)
      a) Drying method : (Oct. 1991 - Feb. 1992)
      b) Storage facilities : (Jan. 1991 - May 1992)
         - To determine aflatoxin contamination, <u>A.flavus</u> infection and moisture content of ear maize samples.

c) Corn sheller improvement : (Sept. 1991 - Feb. 1992)

- To analyze breakage, unshelled moisture content, etc. of shelled maize or corn cob remainder.

3) Data analysis : (Jan. 1992 - June 1992)

- To analyze results of the above five experiments.

4) Annual report : (Mar. 1992 - July 1992)

- To analyze and evaluate the results of experiments conducted this crop season.
- To summarize and make up final report for this crop season.

5) Implementation of final report : (May 1992 - Dec. 1992)

- To evaluate the results of experiments during these four crop seasons.
- To summarize and make up final report for this project.

2. Research works in field

1) Research work : (July 1992 - Sept. 1992)

a) Drying method : (July 1992 - Sept. 1992)

- To conduct drying experiment at farmers' storages to evaluate drying method and to make further modification for it.

b) Storage facilities : (July 1992 - Sept. 1992)

- To modify farmers' storages in use and to investigate transition of internal condition during storage.

c) Corn sheller : (July 1992 - Sept. 1992)

- To shell ear maize of farmers to get data on shelling efficiency; breakage, unshelled, power consumption, etc.

2) Data analysis : (Aug. 1992 - Oct. 1992)

- To analyse results of the above three experiments.

3) Implementation of the final report : (Nov. 1992 - Dec. 1992)

- To evaluate results of this crop season and apply it to the final report of this project.

PLANT PATHOLOGY AND MICROBIOLOGY DIVISION

Microbe Group

1. Research Work : Duration : (Dec. 1991 - Aug. 1992)

- Occurrence and Control of Aflatoxin in maize. Four research activities with in 20 rai will be trialed. The out break of the causal fungi and Aflatoxin contamination in each step of corn production will be tested with control measures.
- Integrated management to prevent mycotoxin contamination in maize. Control measures i.e. biological control pest-management cultivations etc.,will be integrated in 40 areas to evaluate the level of contamination of mycotoxins.
- Detoxification of Aflatoxin in maize. Two chemicals will be testedfor the efficacy on the toxin detoxification.
- Forecasting the out break of Aflatoxin production fungi. Data will be collected from 300 spots and integrated to obtain curve for out break forecasting.

All samples from research activities will be analyzed and reported according to activities in the work plan as Sample Analysis, Data Analysis, Annual Report and Implementation of Final Report.

4.1.1 Justification for requesting experts

Project Leader	- To guide and to lead the JICA staff to implement the activities as mentioned in the work plan.
Project Coordinator	- To coordinate between JICA and DOA staff on administration activities e.g. accounting, equipments, experts and other matters.
Expert in Agronomy, Microbe and Post-Harvest	- To implement the research activities with DOA staff as mentioned in the work plan.

Some short term experts in each field of Agronomy, Microbe, and Post Harvest will be requested as necessary by agreed upon between JICA and DOA staff.

4.1.2 Job description of each expert requested (In addition, Please complete "Expert's Job Description Form" attached to Form P.)

4.2 Fellowship

Field of Study / Training	Total		Total	
	No.	m/m	No.	m/m
(1) Administration	1	1	1	1
(2) Agronomy	1	4	1	4
(3) Microbe	1	4	1	4
(4) Post Harvest	1	4	1	4

4.2.1 Justification for requesting fellowships

Administration - The counterpart in administration group will spend a short study for programme in agricultural management field.

Agronomy - The counterpart (agronomist) in Agronomy section will spend about 3-4 months training course in agronomy.

Microbe - The counterpart (plant pathologist) in Microbe section will spend about 3-4 months training course in microbiology.

Post harvest - The counterpart (agricultural engineer) in Post harvest section will spend about 3-4 months training course in post harvest.

4.3 Equipment (Requested will be done by agreed upon between JICA and DOA sides

Description of equipment item	Amount requested for each item	Unit price (US.$)	Total Cost (US. $)
(1) Research equipment			80,000
(2) Spare parts and consumable items			20,000

4.3.1 Justification for requesting equipment

4.4 Other (e.g. sundry, stipend, construction cost, etc.)

4.4.1 Others

Item requested	Total cost (US.$)
(1).........-...........	-
(2).........-...........	-

5. Thai Government Counterpart Contribution to the Project

Description of Government Counterpart Contribution	Total Contribution		1992
	Already available	To be requested	
(1) Project personnel			
1.1 Professional staff			
- Agricultural Scientist	1,213,800	-	
- Plant Pathologist	1,118,520	-	
- Agricultural Engineer	875,040	-	

Description of Government Counterpart Contribution	Total Contribution		1992
	Already available	To be requested	
1.2 Administrative staff			
- Research Scientist	1,051,080	-	
- Typist & Clerk	60,240	-	
(2) Equipment			
2.1 Premises and building			
- Clearing filling and Levelling	2,300,000	-	
- Fencing, Gate	505,000	-	
- Road Construction	450,000	-	
- Electricity Installation	342,000	-	
- Water Distribution Main	40,000	-	
2.2 Expendable equipment			
- Telephone Installation	100,000	-	
- Office Furniture	98,800	-	
2.3 Non-expendable equipment	-	-	
-None-			
(3) Other (e.g. miscellaneous expense)			
Public Utility Cost :-	588,000	700,000	700,000
- Water Supply	114,000	155,000	155,000
- Electricity Supply	432,000	500,000	500,000
- Telephone	42,000	45,000	45,000
Renumeration Cost :-	3,283,900	4,497,280	4,497,280

6. Related Projects / Activities

6.1 Previous assistance received in fields related to the project

-None-

6.2 Present complementary or supplementary project

-None-

7. Future work plan (the same as 2.7)

Prepared by Mrs. Permpoon Sarnthoy
Foreign Projects Sub-Division
Planning and Technical Division
Tel. 5790890-1, 5796534
Department of Agriculture

Attached document for 4.1.2

Form JD.

Expert's Job Description Form

Post title : Expert in Administration - Project Leader

Duration : 1 Year

Date required : 15 December 1991 - 14 December 1992

Duty station : Maize Quality Improvement Research Centre,
Department of Agriculture

Duties : (Please give detail of each activity)

To guide and to lead the JICA staff to implement the project activities as mentioned in the work plan.

Qualification : a) Academic qualification BS. or higher
b) Required experience 3 - 5 years

Age limit : more than 45 years old

Language : English

Background information : Required a person who have experienced with the foreign projects

Form JD.

Expert's Job Description Form

Post title : Expert in Administration - Project Coordinator

Duration : 1 Year

Date required : 15 December 1991 - 14 December 1992

Duty station : Maize Quality Improvement Research Centre,
Department of Agriculture

Duties : (Please give detail of each activity)

To coordinate between JICA and DOA staff on administration activities e.g. accounting, equipments, experts and other matters.

Qualification : a) Academic qualification BS. or higher

b) Required experience 3 - 5 years

Age limit : Between more than 45 years old

Language : English

Background information : Required a person who used to work with the foreign projects

Form JD.

Expert's Job Description Form

Post title : Expert in Agronomy

Duration : 1 Year

Date required : 15 December 1991 - 14 December 1992

Duty station : Phra Phutthabat Field Crops Experiment Station, Lopburi
The Maize Quality Improvement Research Centre

Duties : (Please give detail of each activity)
To implement the research activities (emphasis on agronomy) with the DOA research scientists.

Qualification : a) Academic qualification BS. or MS.
b) Required experience 5 - 7 years in agriculture

Age limit : Between 40 - 50 years old

Language : English

Background information : Required a person who have experienced in this related field

Form JD.

Expert's Job Description Form

Post title : Expert in Microbe

Duration : 1 year

Date required : 15 December 1991 - 14 December 1992

Duty station : Maize Quality Improvement Research Centre, Department of Agriculture

Duties : (Please give detail of each activity)

To implement the microbiology research activities as mentioned in the work plan of the project.

Qualification : a) Academic qualification BS. or MS.

b) Required experience 4 - 7 years in this related field

Age limit : Between 60 years old to 65 years old

Language : English

Background information : Required a person who have experienced in this related field

Form JD.

Expert's Job Description Form

Post title : Expert in Post Harvest

Duration : 1 year

Date required : 15 December 1991 - 14 December 1992

Duty station : Prathumthanee and the Maize Quality Improvement Research Centre, Department of Agriculture

Duties : (Please give detail of each activity)

To implement the research activities on post harvest technologies of this project.

Qualification : a) Academic qualification BS. or MS.

b) Required experience 1 - 2 years in this related field

Age limit : Between 28 years old to 40 years old

Language : English

Background information : Required a person who have experienced in this related field

⑤ メイズ生産性シュミレーションモデル計画協力要請書

Form P.

REQUEST FOR TECHNICAL ASSISTANCE

PROJECT TITLE : SIMULATION MODEL OF MAIZE PRODUCTIVITY IN THAILAND

REQUESTING AGENCY : DEPARTMENT OF AGRICULTURE
MINISTRY OF AGRICULTURE AND COOPERATIVES

PROPOSED SOURCE OF ASSISTANCE : JAPAN

1. Background Information and Justification for the Project.

Recent economical development in Thailand is required higher crop productivity for improving standard of life in the rural area. Maize as an important agricultural commodity in Thailand is produced not only as the commodity for export to earn foreign currency, however, the recent change of industrial structure, also required maize as feed for live-stock industries in the domestic market. However, the production of maize in Thailand is unstable due to climate, soil condition and other factors.

In several developed and developing countries where the same problem of crop production as Thailand exist, crops growth simulation models are used to lessen these problems. Simulation models can forecast crop production conditions and can also simulate yield under different weather regimes. Thus, unfavorable conditions of growing can be avoid. The models can also be used to simulate production and water use in order to survey and evaluate new sites, crops and management techniques before embarking on a large scale program. They can also establish the impact of year to year weather variability on the crops much faster than with more conventional methods.

Since simulation model has never been used in Thailand before, development of this kind of simulation model for maize will be the most useful for maize production in Thailand. Simulation model of maize can be applied to various climate conditions by changing the data. It can promote better understanding of maize production and if the climatic condition of future can be used, it will be possible to predict the productivity and quality of maize before planting time.

2. Details of the Project

2.1 Program Goal or Development Objective

The productivity and quality of maize would be possibly predicted before planting time so that the supply and demand of maize could be estimated. Therefore, the maize marketing, both domestic and expert could be adjusted to the most benefit of farmers and the country.

2.2 Project Objective or Immediate Objective

- To develop simulation model of maize productivity in Thailand.
- To use the simulation model as a tool for agricultural research and development.

2.3 Project Output or Conditions Expected at Completion of the Project

- Enable to forecast Maize Production in Thailand
  - Yield, production and planting area
  - Crop development and conditions
  - Area damaged
  - etc.
- To clarify the production pattern and the limiting factor of maize productivity in the growing area.
- To release the information to the market to estimate the supply and demand of maize.
- Simulation model can be used to support field

research and extension, sometime, can replace some field trials, and can give field trial result broader and deeper perspective.

- Using simulation model can decrease costly and time-consuming agricultural research and experiment.

2.4 Project Activity

The following activities will be carried out during the project period.

a) Collection of weather data consist of daily radiation, rainfall, maximum and minimum temperature, windspeed and relative humidity for the entire period of the project.

b) Collection of soil data consist of soil moisture content when air dry, wilting point, field capacity and saturation; soil types and soil depth at different locations and years.

c) Collection of agronomical and physiological crops data consist of dry matter of maize components at various phenological development stages, growth duration at vegetative and reproductive stage. Crop data will be collected from field experiments conducting at all project site for the whole period of the project.

d) All data collection will be used to develop personal computer simulation modeling program for Thai maize productivity which based the development on the modified modeling program of Mr. Tsuiki at the MQIRC Project. The original model was constructed by the group of researcher at the National Grassland Research Institute, Minister of

Agriculture, Fishery and Forestry in the Government of Japan.

e) Comparison of experimental result with that of simulation result every year in order to make the adjustment of model. Final simulation model will be completed at the last of the project.

f) Limiting factor for the maize production in the respective maize production area will be described and publicized for the technical personal in the country.

2.5 Project Workplan

Activities \ Year	1993	1994	1995	1996	1997
1) Preparation and Equipment Setting	--------				
2) Data Collection	--------	--------	--------	--------	----
3) Field Experiment	--------	--------	--------	--------	----
4) Data Summarize and Analysis	----	----	----	----	----
5) Analysis and Simulation model	----	----	----	----	---
6) Model Check	---	---	---	---	---
7) Final Simulation Model					-----

2.6 Duration of the Project : Starting

From 1993 to 1997

2.7 Project Sites

The project will be carried out at the major maize production area where the Field Crops Research Institute has Research Center or Experimental Station (Lopburi, Nakhon Sawan, Petchabun, Chiang Mai, Ubon Ratchathani, and Nakhon Ratchasima, etc.,)

3. Details of the Implementing/Operating Agency

Field Crops Research Institute, Department of Agriculture, Minister of Agriculture and Cooperatives, Thailand, to be an executing agency.

The main activities of the Project will be carried out at Nakhon Sawan Field Crops Research Center, Field Crop Research Institute.

Project leader will be setting in the Institute. Research leader will be stationed at the Center. Research staff will be worked at responsible site.

Organization Chart

Institutions	Staff Personal
- Field Crop Research Institute Bangkhen, Bangkok	Director of the Institute as Project Leader
- Field Crop Research Center Tak Fa, Nakhon Sawan	Research Leader
- Observation Sites	
Nakhon Sawan	Research Staff
Lopburi	Research Staff
Petchabun	Research Staff
Nakhon Ratchasima	Research Staff
Prachin Buri	Research Staff
Ubon Ratchathani	Research Staff

Institutions	Staff Personal
Chiang Mai	Research Staff

4.Assistance Requested

The request covers assistance in the technical service, fellowships and equipment for carrying out the project activities over five years period are as follow:

4.1 Expert

	1993 m/m	1994 m/m	1995 m/m	1996 m/m	1997 m/m	Total m/m
Simulation Model	4	4	4	4	6	22
Plant Physiology	4	4	4	4	5	21
Soil	5	-	4	-	4	13
Agronomy	4	-	4	-	5	13
Others if necessary	3	3	-	3	3	12
Total	20	11	16	11	25	81

4.1.1 Justification for Requesting Experts

This request is for Japanese experts to assist in implementing the project, to supervise on developing simulation model and guide on the overall experiments used in adapting model.

4.1.2 Job Description of Each Expert Requested are attached.

4.2 Fellowship

The distribution of fellowship are given below.

Year	Studytour For senior scientists (NO)	Training Researcher (NO)	Total
1993	1	2	3
1994	1	1	2
1995	1	1	2
1996	-	1	1
1997	-	1	1
Total	3	6	9

4.2.1 Justification for Requesting Fellowship

The techniques to be used in research work on this project are somewhat new to Thailand, therefore study-tour and training in Japan where this kinds of techniques are very successful, will be needed for senior scientists, researcher and staffs of the project.

4.3 Equipment

The project requests the necessary facility and equipment to conduct research work as listed as follows;

List of Equipments

- Meteorological station with data logger	7 sets
- Dryer	6 sets
- Leaf Area Meter	7 sets
- Weighing Balance	7 sets
- Personal Computer	2 sets
- Lap Top Type Personal Computer	7 sets

- Photosynthesis Measurement Apparatus 6 sets
- Soil Moisture Measurement Apparatus 70 sets
- Uninterruptable Power Supply 6 sets
- Voltage Power Stabilizer 6 sets
- Electric Generator 6 sets
- Double Cab Pick Up Truck 3 sets
- Copying Machine 2 sets

5. Thai Government Counterpart Contribution to the Project

5.1 Japan's Contribution This request is extended to the government of Japan for Japanese Government's collaboration to cover the cost which include experts, fellowship, material and equipment.

5.2 Thailand's Contribution The Department of Agriculture will provide a number of counterparts to work with the Japanese expert over the project period. The office work, and facilities in the experimental fields are also provided.

6. Related Project/Activities

This project is related with the Maize Quality Improvement Research Center Project (MQIRC Project) which was under the technical cooperation of the Japanese Government at Department of Agriculture, Ministry of Agriculture and Agricultural Co-operatives of The Royal Thai Government. The Maize Quality Improvement Research Center Project was initiated the work of developing simulation model for maize,. but the model has not been completed due to the termination of the MQIRC Project.

Form JD.

Expert's Job Description Form

Post title : Expert in Simulation Model

Duration : 4 months/year for 5 years

Date required : April 1993

Duty station : Nakhon Sawan Field Crop Research Center and
Phra Phutthabat Field Crop Experiment Station

Duties : To supervise on developing Personal computer simulation modeling program for Thai maize productivity

Qualification : a) Academic qualification at least Master Degree

b) Required experience 5 years

Age limit : Between - to -

Language : English

Background information : -

Form JD.

Expert's Job Description Form

Post title : Expert in Plant Physiology

Duration : 4 - 5 months/year for 5 years

Date required : May 1993

Duty Station : Nakhon Sawan Field Crop Research Center and Phra Phutthabat Field Crop Experiment Station

Duties : Work on collection of physiological crops data and Meteorological data relating to maize development at various growth stages both from experiment and in nature.

Qualification : a) Academic qualification at least Master Degree

b) Required experience 5 years

Age limit : Between - to -

Language : English

Background information : -

Form JD.

Expert's Job Description Form

Post title : Expert in Soil

Duration : 4 - 5 months/year for 3 years

Date required : May 1993

Duty Station : Work at major maize production area where Field Crop Research Institute has Research Center and Experiment Station

Duties : Collection of soil data consist of soil moisture content when air dry, wilting point, field capacity and saturation; soil types and soil depth at different locations and years.

Qualification : a) Academic qualification at least B.Sc.

b) Required experience 4 - 5 years

Age limit : Between - to -

Language : English

Background information : -

Form JD.

Expert's Job Description Form

Post title : Expert in Agronomy

Duration : 4 - 5 months/year for 3 years

Date required : May 1993

Duty station : Nakhon Sawan Field Crop Research Center and
Phra Phutthabat Field Crop Experiment Station

Duties : To conduct and advise on field experiments in order to collect agronomical crops data which consist of maize growth development at various vegetative and reproductive stage.

Qualification : a) Academic qualification at least
b) Required experience 4 - 5 years

Age limit : Between - to -

Language : English

Background information : -

Prepared by :

1. Mr. Narongsak Senanarong

2. Mr. Prasop Debyasuvarn

3. Mr. Werawat Nilrattanakoon

Field Crop Research Institute

Tel. 579-3930 - 32

JICA