THAI AGRICULTURAL STANDARD

TAS 5902-2010

GOOD AGRICULTURAL PRACTICES FOR SUGARCANE

National Bureau of Agricultural Commodity and Food Standards
Ministry of Agriculture and Cooperatives

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Thailand is in the top rank of the exporters of sugar in the world. Nevertheless, there is still needs to formulate the good practices in sugarcane cultivation to produce safe and quality raw material for sugar processing. Additionally, the practices shall also include the environment issues that might be the case of trade barrier in the future. Therefore, the Agricultural Standards Committee deems it necessary to establish an agricultural standard on Good Agricultural Practices for Sugarcane.

The standard is based on the information of the following documents:

Department of Agriculture. 2008. Good Agricultural Practices for Sugarcane (GAP No. 19). 1st print. Bangkok: the Agricultural Co-operatives Federation of Thailand Publisher Ltd., pp. 26.

TAS 9001- 2009. Thai Agricultural Standard: Good Agricultural Practices for Food Crops, Bangkok: National Bureau of Agricultural Commodity and food Standards.

NOTIFICATION OF THE MINISTRY OF AGRICULTURE AND COOPERATIVES

SUBJECT: THAI AGRICULTURAL STANDARD:

GOOD AGRICULTURAL PRACTICES FOR SUGARCANE

UNDER THE AGRICULTURAL STANDARDS ACT B.E. 2551 (2008)

Whereas the Agricultural Standards Committee deems it necessary to establish an agricultural standard on Good Agricultural Practices for Sugarcane as a voluntary standard in accordance with the Agricultural Standards Act B.E. 2551 (2008) to promote such agricultural commodity to meet its standard on quality and safety.

By virtue of Section 5, Section 15 and Section 16 of the Agricultural Standards Act B.E. 2551(2008), the Minister of Agriculture and Cooperatives hereby issues this Notification on the Establishment of Agricultural Standard: Good Agricultural Practices for Sugarcane (TAS 5902-2010) as a voluntary standard, details of which are attached herewith.

Notified on 26 August B.E. 2553 (2010)
Mr. Theera Wongsamut
Minister of Agriculture and Cooperatives

THAI AGRICULTURAL STANDARD
GOOD AGRICULTURAL PRACTICES FOR SUGARCANE

1. SCOPE

This agricultural standard establishes the requirements for good agricultural practices for sugarcane from planting area, to the sugar mills in order to obtain good quality, safe and suitable raw material for the industry by taking into account the environmental impact, health, safety and welfare of workers.

2. DEFINITIONS

For the purpose of this standard:

2.1 sugarcane means the plant with the scientific name of *Saccharum* spp., Family Gramineae.

2.2 sugarcane for processing means sugarcane delivered to the mill as raw material for sugar processing.

2.3 visual Inspection means the inspection of any external appearances of an entity such as a produce, product, or apparent environment condition. This is basically examined by eyes and other sensory evaluation may be applied depending on quality attributes in question, or additional tools such as magnifying glass could be used. The operation or process inspection is also included.

2.4 pesticide means a hazardous substance used in agriculture regulated by the Department of Agriculture in accordance with the Notification of the Ministry of Industry entitled the Lists of Hazardous Substances issued by virtue of the Hazardous Substance Act B.E.2535 (1992) and its amendments.

2.5 pest means living organism such as disease, insect, animal and weed that is harmful to crop.

2.6 traceability/product tracing means the ability to follow the movement of an agricultural commodity and food through specified stage(s) of production, processing and distribution.

3 . REQUIREMENTS AND INSPECTION METHODS

Requirements and inspection methods shall be as in Table 1.

Table 1 Requirement and Inspection Methods
(Section 3)

ITEMS	REQUIREMENTS	INSPECTION METHODS
1. Planting area	1. The planting area shall not be located in an area that poses any contamination risk of heavy metal, and pesticide over the requirements regulated by relevant laws and regulations.	1. Visual inspection of the environmental setting. If there is any risk, the soil and water quality shall be analysed.
2. Use of pesticides	2.1 The worker shall have the basic knowledge on sugarcane pests and the proper use of pesticides.	2.1 Check workers' knowledge, practices, or training record.
	2.2 If pesticide is used, follow the recommendations of the Department of Agriculture (DOA), or the instruction on the labels registered with the DOA.	2.2.1 Check records of pesticide application. 2.2.2 In case there is evidence or doubt of improper use, sample the sugarcane for pesticide residues analysis.
	2.3 The pesticides shall be properly stored and the empty container shall be properly destroyed.	2.3.1 Check pesticide storage. 2.3.2 Check empty pesticide container management.
3. Pre-harvest management	3.1 Soil shall be conserved and nourished.	3.1 Visual inspection or interview and check records.
	3.2 Stem cuttings that have complete buds, free from pests and of the required variety shall be selected.	3.2 Visual inspection or interview and check records.

ITEMS	REQUIREMENTS	INSPECTION METHODS
	3.3 Pest shall be efficiently controlled after planting and harvesting by following the directions of the concerned agencies.	3.3 Check records and/or visual inspection.
4. Harvest and post harvest management	4.1 Sugarcane shall be harvested at the age of not less than 10 months or the Degree Brix of juice is not less than 20 ° Bx .	4.1 Check records.
	4.2 Burning field for harvest and after harvest field management shall be prohibited.	4.2 Visual inspection or interview.
5. Transport	5.1 Harvested sugarcane shall be rapidly transported to the mill no later than three days.	5.1 Check records.
	5.2 Foreign matters such as soil, gravel, or objects other than sugarcane including undesirable parts of sugarcane (leave and shoot) shall not be allowed on the transporting vehicle according to the related Notification of the Office of The Cane and Sugar Board.	5.2 Check record of the report of the working group of production control at the mill.
6. Worker health	6. Provide appropriate and sufficient health care to workers.	6. Visual inspection and interview.
7. Record keeping	7.1 The following data shall be recorded for auditing and traceability at the farm level. - number of plots, yields per rai, and degree Brix - the sources of production inputs such as stem cuttings, fertilizers and pesticides - use of pesticides - evidence of workers' training on pest control and pesticide application (if any) - soil conservation and nourishment - pest control - date of planting and harvest	7.1 Check records.

ITEMS	REQUIREMENTS	INSPECTION METHODS
	- collectors / buyers - purchasing contract - report of the working group of production control	
	7.2 Records shall be kept at least 2 years.	7.2 Check records.

4 . GUIDANCE ON GOOD AGRICULTURAL PRACTICES FOR SUGARCANE

These recommendations on good agricultural practices for sugarcane are to provide farmers with good practices from planting to the sugar mills in order to obtain good quality, safety and suitable raw material for processing. Details are given in Appendix A.

APPENDIX A

GUIDANCE ON GOOD AGRICULTURAL PRACTICES FOR SUGARCANE

(Section 4)

A.1 Planting area

A.1.1 The planting area shall not be located in an area that poses the risk of hazardous substances[1/] causing residue in the produce. If the environment of planting area is in the location exposed to any risk of heavy metal and pesticide contamination such as near industrial plants or the areas with heavy use of chemicals or pesticides, soil shall be sampled at least once for analysis at governmental laboratory or officially accredited laboratory. The analytical reports shall be kept as evidence.

A.1.2 If water used is obtained from the source where there is a contamination risk of hazardous substances to the produce, water should be sampled before planting or during the supply of water to sugarcane at least once. The sample shall be sent for analysis at governmental laboratory or officially accredited laboratory. The analytical reports shall be kept as evidence.

A.1.3 The planting area shall be in compliance with the relevant laws and regulations such as the Notification of Office of The Cane and Sugar Board entitled the Zoning of Sugarcane Cultivation and the Notification of National Environment Board No.25 entitled Soil Quality Standards (in case the risk of heavy metal and pesticide contamination to the environment).

A.1.4 The records of planting areas shall be identified by name of owner, address, the name of plot keeper (if any) and address, plot location, types and varieties, land use history dating back at least 2 years and other details according to Record Form 1 (General information of the farmer)

A.2 Use of pesticides

A.2.1 Workers shall have basic knowledge on sugarcane pests and regularly survey pest infestation such as White leaf, Red rot, Smut, Green grassy shoot, Stem borers, Early shoot borers, Stem boring grub, Termite, White grab, Sugarcane leaf-hopper and other pests. Details of major pest are defined in Appendix B.

The worker shall have basic knowledge on proper pesticides and dosage appropriate to the pest. The worker shall avoid repeated use of the same pesticides in order to prevent the pest resistance.

Pest control measures should be appropriate and based on monitoring and survey of pest population. Integrated pest management (IPM) should be appropriate to reduce the application of pesticides. IPM means the pest management system by gathering the details of pest population changes to its related environment. All combination of appropriate

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[1/] Hazardous substances means a substance or any articles including chemicals, microorganisms or microbial toxins which may be harmful to human, animal, plant, property or environment.

techniques and methods are brought into practices to continuously reduce the number of pest to the economic threshold level.

A.2.2 The use of pesticide shall follow the government recommendations or other agencies or the instruction on the labels registered with the DOA, Ministry of Agriculture and Cooperatives. The application shall be coincided with the pest found, and such application shall be ceased before harvesting in accordance with the specified withdrawal period on the label of each pesticide or the recommendations from the DOA. The use of pesticide shall be recorded according to the Record Form 3 (Pest survey and pesticide application).

Workers should have knowledge about personal protection from the exposure to pesticides and the use of first aid kit.

Pesticide sprayer should be checked and of good condition for efficient use. In order to protect from the pesticide exposure, the workers should wear proper clothes with personal protective equipment (PPE) such as masks, gloves, hats and shoes.

After each pesticide application, workers shall take a bath, shampoo, and immediately change clothes. Used clothes shall be cleaned every time and separated from the normal laundry.

A.2.3 Each pesticide shall be clearly labeled and kept in order separated from fertilizers, plant growth regulators, plant nutrient supplements, and PPE. The leftover pesticide shall be tightly closed and kept in the pesticide storage provided with secure location, sunlight and rain protection, good ventilation, out of reach from children and pets.

The empty pesticide containers shall be tampered to prevent the reuse and discarded at the designated area or buried at a distance away from public water source and with the depth to prevent animal digging. Burning of empty containers is prohibited.

A.3 Pre- harvest management

A.3.1 Soil conservation and nourishment

Sugarcane is well grown in loam, clay loam, or sandy loam. The topographic area may be sloped, and hilly that may cause high erosion by forces of rain and wind. Furthermore, sugarcane requires big plantation. In such conditions, there is a need for conservation and nourishment to sustain soil fertility by the following practices:

(1) Leaves and debris should be used for mulching to retain soil moisture or plow over to increase organic matter, to prevent weed germination and to reduce the infestation of stem borers. Leave burning should be allowed in order to prevent the losses of moisture and living organisms in soil.

(2) Organic fertilizer should be used to increase organic matter. The organic fertilizer should come from the complete fermentation or other processes to obtain complete decomposition and be able to decrease pathogenic microorganisms.

(3) The chemical fertilizer registered by the DOA, Ministry of Agriculture and Cooperatives shall be used based on the analysis of soil nutrients.

For each fertilizer application, soil shall be adequately moist. The fertilizer should be applied 10 cm away from sugarcane row along both sides and then till over except the application of fertilizer for bottom dressing.

(4) The growing of crop such as sunhemp or *Sesbania rostrata* at the rate of 5 kg per rai or hemp, sesbania, green bean at the rate of 8 kg per rai or cowpea at the rate of 10 kg per rai should be recommended. Tillage of such crop at 75% flowering stage, or after seed harvest should be done for green manure.

(5) The soil amendment such as filter cake from sugar mill at the rate of 5,000 - 8,000 kilogram dry weight per rai shall be used except pH of the soil is more than 7.5.

(6) In case of sloping area, contour line shall be applied to prevent soil erosion.

A.3.2 The selection of stem cuttings (cane setts)

A.3.2.1 Stem cuttings with healthy buds, pest free and of the specific variety should be selected.

A.3.2.2 The selection of sugarcane for processing should be in accordance with the official recommendation or the requirements of related laws and regulations such as the notification of the Office of the Cane and Sugar Board entitled the appropriate sugarcane varieties to encourage cultivation in the designated areas.

A.3.2.3 Multiplication plots should be prepared to decrease the risk of pest outbreak, and cost saving as recommended in Appendix C. Otherwise, select from the reliable sources which do not cause the pest harborage and able to be traced.

A.3.2.4 Use stem cuttings at the proper ages, seasons and planting method particularly, at the age of 8-10 months for early rainy season in the irrigated areas and at the age of 10-12 months for the late rainy season.

A.3.2.5 Use a knife to cut the stem close to the base and cut off the top about 20 cm below the fully unfurled leaves and remove the leaf sheathes and ready to plant.

A.3.3 Pest control

A.3.3.1 Pest control shall be in accordance with the recommendations of the related official agencies.

A3.3.2 The Department of Agriculture has provided the pest control, as tabulated in Appendix B: Major Pest of Concern.

A3.3.3 Weed control

A.3.3.3.1 Weed shall be regularly controlled, specifically about 2 months after planting.

A.3.3.3.2 Weed control of first year planting (plant cane)[2]

(1) Plough 1-2 times, dry soil 7-10 days, till the soil and then completely get rid of the weeds (e.g. roots, bulb, rhizome, tubers and stolons of perennial weeds) before planting.

(2) Weed control by labours or machines once or twice during the ages of 1-2 months or when weeds emerge 4 to 5 leaves or prior to weed flowering.

(3) In case of inefficiency of weed control by labours or machines, herbicide application shall be followed by the recommendations of the Department of Agriculture or other related official agencies.

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[2] Plant cane means cane germinated from stem cuttings.

A.3.3.3.3 Weed control of ratoon [3]

(1) After trimming the ratoon close to the ground, cover soil with leaves and shoots to retain moisture and prevent weed germination.

(2) Use the leaf thresher, disc plough, or rotary blade tractors to turnover leaves in soil prior to fertilization.

(3) At the stage of tillering, if there are plenty of weeds, it should be controlled by labours or machines once or use herbicides according to the instruction of the Department of Agriculture or other related official agencies.

A.3.3.3.4 Major weeds are as follows:

(1) Annual weeds are the weeds with complete life cycle in one season, naturally spread by seeds:

- Narrow leave types such as goose grass, southern crab grass, jungle rice grass, crowfoot grass, sprangletop grass, mission grass, etc.

- Broad leave types such as spiny amaranth, painted spurge, horse purslane, gaeden spurge, goat weed, mild spikenard bush-tea, country mallow, ground burnut, etc.

(2) Perennial weeds are weeds mostly spread by roots, rhizomes, tubers and stems rather than seeds:

- Narrow leave types such as running grass, torpido grass, wire grass, para grass, cogongrass, etc.

- Broad leave types such as spreading dayflower, etc.

- Sedge types such as nut grass, etc.

A.4 Harvest and post harvest management

A.4.1 Appropriate harvesting time

A.4.1.1 Sugarcane shall be harvested at the age of not less than 10 months.

A.4.1.2 Sugarcane juice shall not be less than 20 ° Bx or more than 10 C.C.S[4] (Commercial Cane Sugar).

A.4.2 Sugarcane leaf burning is not allowed at the harvesting time because the quality of sugarcane will be reduced. The methods for proper harvesting are as follows:

A.4.2.1 By labour

(1) Use a knife to trim both leaves and leaf sheathes to reduce the amount of leaf fragments mixed with the cane on the truckload.

(2) The sugarcane should be cut at the base close to the ground. The sugarcane (not yet flowered) should be cut at the top about 25-30 cm below the leaf base and the one that already flowered should be cut about 100-150 cm below the flag leaf.

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[3] Ratoon means cane germinated from the harvested plant cane. The cane germinated from the plant cane is called first ratoon and the cane germinated from the first ratoon is called the second ratoon.

[4] C.C.S. means the percentage of sucrose produced from a specific tonnage of canes. For example, if the C.C.S. is equal to 10 indicating that 1 tonne of cane shall obtain the maximum of 100 kg of sucrose.

(3) Bundle both ends with the cut leaf top and line them along the field awaiting for transportation to the mill.

A.4.2.2 By machine

Use the harvester by setting the lower blade close to the ground and the upper blade at 25-30 cm below the below the fully unfurled leaves. The blower attached to the harvester automatically cleans the debris before the sugarcane is transported to the mill.

A.4.3 Plot management after harvest

Till over leaves and the debris of canes (including the demolished old sugarcane ratoon) and mix into the soil to increase the soil fertility to reduce the use of chemical fertilizer and maintenance cost of the ratoon.

A.5 Transportation

A.5.1 Harvested sugarcanes shall be transported to the mill no later than 3 days for keeping the good quality and yield weight.

A.5.2 Prepare the vehicles for transportation before harvesting.

A.5.3 Truck used to carry canes shall be clean and in proper size for the truckload. The weights of truckload shall be in compliance with the regulation of the Director of the Department of Rural Roads under the Highway Act B.E. 2535 (1992) and its amendments. The truck shall not be used to load soil, animals, animal manure, chemical fertilizer, and pesticides which may contaminate the canes unless the vehicle is properly cleaned before loading.

A.5.4 Be careful not to allow foreign matters such as soil, gravel, or other matters including the undesired parts of canes on the truckload. The related regulations of the Office of the Cane and Sugar Board such as the Order of the Office of the Cane and Sugar Board on the Principles, Procedures, and Conditions on the Dispute of Cane Quality, Burned Cane, Cane Purity, and the Determination of Mill Efficiency B.E. 2549 (2006) shall be applied. In general, foreign matters shall not exceed 7-10% by weight observed during the unloading depending on inspection methods. After crushing, soil or sand should not be more than 3%.

A.6 Worker Health

A.6.1 Appropriate and sufficient health care shall be provided for the workers. In case workers are sick, they should inform the manager. The workers who expose to pesticides should have appropriate health check.

A.6.2 The worker welfares such as meal, water, first-aid kit shall be appropriately provided at the site.

A.7 Record keeping

A.7.1 Record keeping for auditing and traceability at the farm level shall be as follows,
- number of plots, yields per rai, and degree Brix
- sources of production inputs such as stem cuttings, fertilizers and pesticides
- use of pesticides
- evidences of workers' training on pest control and pesticide application (if any)
- soil conservation and nourishment
- pest control

- date of planting and harvest
- Information of the selling date, name of collectors or the mills . The document (Form Or.1) of the office of the Cane and Sugar Board shall be used as evidence.
- purchasing contract
- report of the working group of production control

A.7.2 Records shall be kept at least 2 years.

SAMPLE OF RECORD FORM 1

GENERAL INFORMATION OF FARMERS (Page 1/4)

(Section A.1.4)

Year .....

Farmer's name (Mr./Mrs./Miss) ..... Family name .....
Registration Number □□□□□□□□□□□□□ Area ..... Rai
Number of Plot ..... Plot(s) Plot no……...……Code…….....……
Name of Farmer Association…….....……Contracted Mill……
Address, Village Name ..... Moo ..... No. .....
Street ..... Soi.....
Sub-district ..... District ..... Province .....
Postal Code ..... Tel ..... Fax .....
E-mail ..... Website .....

Contact Person or Representative
(Mr./Mrs./Miss) ..... Family Name .....
Address, Village Name ..... Moo ..... No. .....
Street ..... Soi.....
Sub-district ..... District ..... Province .....
Postal Code ..... Tel ..... Fax .....
E-mail ..... Website .....

Signature.....
(.....)

Signature of Contact Person or Representative .....
(.....)

SAMPLE OF RECORD FORM 1

GENERAL INFORMATION OF FARMERS (Page 2/4)

(Section A.1.4)

Farmer's Name Mr./Mrs./Miss ..... Family Name .....

Registration Number □□□□□□□□□□□□ Plot code.....….....

Moo ..... Sub-district .....

District ..... Province ..... Postal Code .....

Total Number ..... Plot(s) Area ..... Rai

Map of plot location, communication route and important places in the vicinity for convenience in travelling to the plot.

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SAMPLE OF RECORD FORM 1

GENERAL INFORMATION OF FARMERS (Page 3/4)

(Section A.1.4)

Plot Location, Moo ..... Sub-district ..... District .....
Province ..... Area ..... Rai

1.1 Planting Variety

Plot No. ..... Planting year ..... Plot code ..... Variety ……..
Planting date..... Harvest date ..... Sweetness..... °Bx
Plot No. ..... Planting year ..... Plot code ..... Variety ……..
Planting date..... Harvest date ..... Sweetness..... °Bx

1.2 Water
- water analytical report ☐ Yes ☐ No
- Watering system……rate……L/hour

1.3 Soil
- soil analytical report ☐ Yes ☐ No
Soil type .....

1.4 History of land use for the past 2 years

☐ Area has never been used for agricultural production
☐ Area has been used for agricultural production
Crops cultivated Year 1 .....
Year 2 .....

1.5 History of pest infestation and control measure

Name of pest..... Year..... Damaged area .....% Control action .....
Name of pest..... Year..... Damaged area .....% Control action .....
Name of pest..... Year..... Damaged area .....% Control action .....

1.6 soil conservation and nourishment

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.....
.....

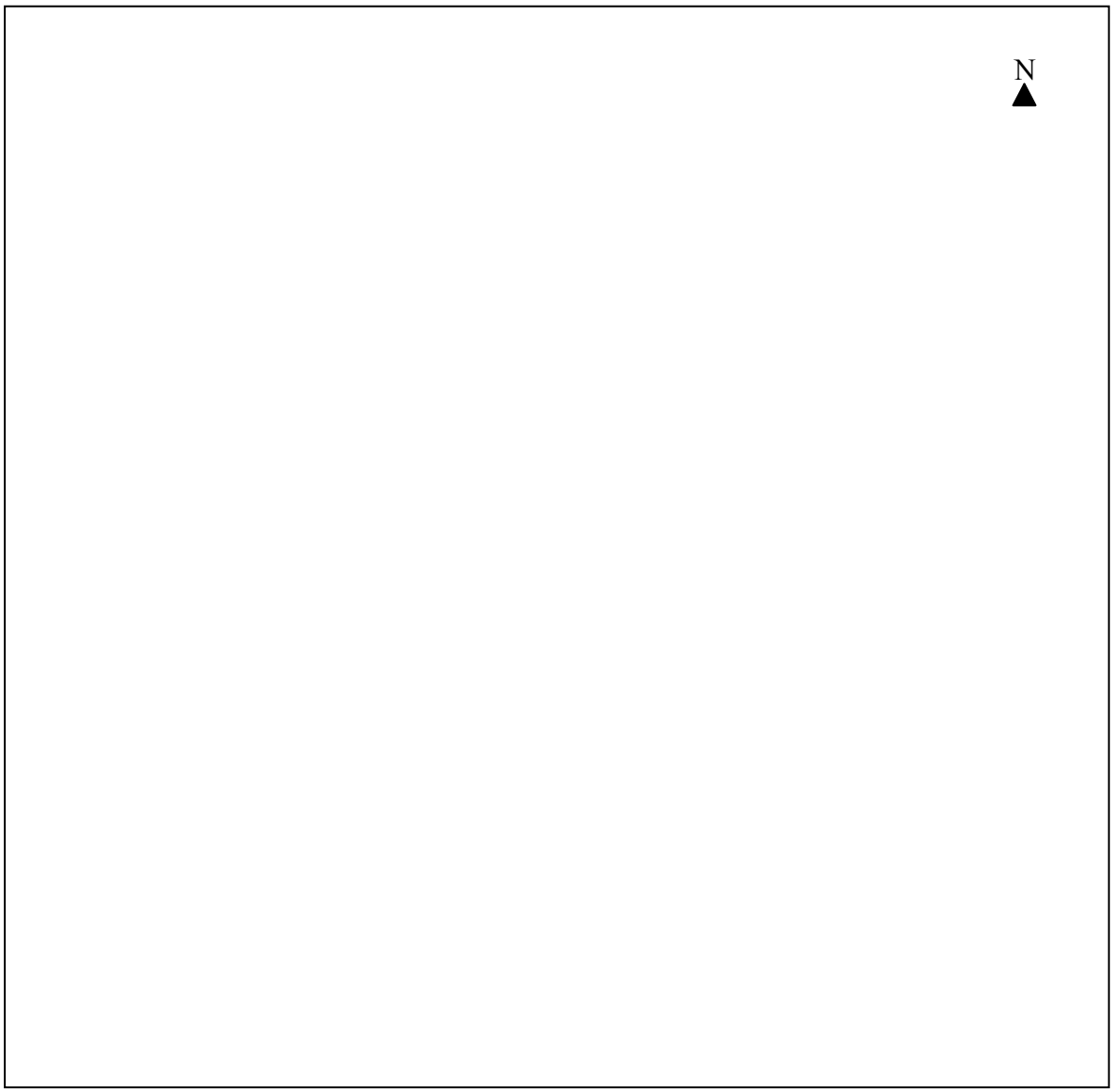
SAMPLE OF RECORD FORM 1

GENERAL INFORMATION OF FARMERS (Page 4/4)

(Section A.1.4)

Plot number..... Plot code..... Year .....

Layout of the plot indicating the followings:
- Planting area
- Areas for chemical mixing, storage, cleaning of spraying equipment
- Area or facilities for composting activity and storage of compost and soil amendment
- Buildings and roads



SAMPLE OF RECORD FORM 2

LIST AND DETAIL OF PRODUCTION INPUTS

(Section A.2.2, A.3.1 and A.3.2)

Farmer's name Mr./Mrs./Miss ..... Family name .....

Registration number □□□□□□□□□□□□□

Plot Number	Item	Name of production inputs	Purchasing Date	Amount	Source of purchasing	Specific detail	Recorder

SAMPLE OF RECORD FORM 3

PEST SURVEY AND PESTICIDE APPLICATION

(Section A.2.2)

Farmer's name……Family name…….
Registration Number □□□□□□□□□□□□ Plot code……
Planting area…….. Plot Number……. Variety…… Plot size……Rai. Crop year……..

Production process	Pest survey				Pesticide application					Other type of control	Worker's name
	Date	Survey Result			Date	Pesticide name	Active ingredient (%), formula	Dosage*	Total application		
		pest	Not Found	Found							

*Note application dosage used e.g. g/Rai or kg/Rai or ml/water 20 L

APPENDIX B

MAJOR PEST OF CONCERN

(Section A.2.1 and Section A.3.3.2)

Outbreak period, major diseases and pests and control methods are shown as follows:

Outbreak Period	Major Diseases and Pests	Control Methods
Serious outbreak during rainy season especially the planting area of sandy loam soil.	**White leaf** Caused by Phytoplasma Symptoms Sugarcane leaves are narrow shaped, light green or white color, profusely tilled, dwarf and undeveloped. The symptoms are found at every growth stage. The symptom is significant for the ratoon at the age of 4-5 months. The symptom can be observed from visible white young shoots of stubbles or side buds. The yield reduces 30 to 100% Spread of the disease The disease can be found in every planting area. It can be transmitted through infected stem cuttings.	- Do not use stem cuttings from the infected planting area. If necessary, soak in hot water at 52°C for half an hour and leave them over night and soak the cutting again at 50°C for two hours. - Dig up the infected canes and destroy outside the field. - In the area of regular outbreak, destroy the stubbles after harvest. - Use crop rotation to cut disease life cycle such as angola pea, jack bean, soybean, and corn.
Rapid outbreak in rainy season.	**Red rot** Caused by *Physalospora tucumanensis* Speg.(perfect stage) and *Colletotrichum falcatum* Went. (imperfect stage) Symptoms The top becomes yellow, and dry. The appearance of reddish lesions is on the internal tissue. This symptom is often found in conjunction with the wither disease caused by *Fusarium monilitorme* or *F. subglutinans* and called "the red bruised wither disease" causing violet-brown lesions and cane dying. The symptom in new planted canes will appear after 6 to 7 months, The yield will reduce 20 to 70%. The symptom of ratoon will appear after trimming 2 to 3 months causing the yield to decrease 50 to 100 %. Spread of the disease. Spread of the disease is found in the Central region of the country. Primary spread is through infected stem cuttings and the secondary spread is through soil, water and wind borne spores.	- Do not grow any specific variety in a wide area. - Use disease resistant varieties. - Do not use varieties from the diseased sources. -If the field is infected, refrain from watering and fertilizing and rapidly cut the crops to mill. - After harvesting, dig and burn the infected stubbles then plough and sundry the soil two to three times before next planting.

Outbreak Period	Major Diseases and Pests	Control Methods
Throughout the season	**Smut** Caused by *Ustilago scitaminea* Syd, & P. Syd. Symptoms Sugarcane tip looks like a long dark whip. The symptom is found more serious in the ratoon than the plant cane. The ratoons are stunt, less sprouting or forming of thin stalks, dry and dead. The yield is reduced 50 to 80%. The quality is deteriorated 10 to 20% Spread of the disease. The infection is found in all regions. The fungus can be spread through stem cuttings then spread to soil and the spores can be spread through wind and water.	- Use the resistant varieties - Do not use varieties from the diseased sources. - Soak the cuttings in fungicide for half an hour before planting. For example, triadimefonthen 40 g/20 1 of water or propiconazol 16 g/20 1 of water before planting.
Throughout the season	**Green Grassy Shoot** Caused by Phytoplasma Symptoms Profuse tillering with narrow green leaves giving a lemongrass like appearance. For serious outbreak in ratoon crop, there is no cane to harvest. The yield is reduced 20 to 50% in plant cane and totally lost in ratoon. Spread of the disease. The outbreak is found in the Central region of the country. The fungus can be spread through the stem cuttings.	- Use resistant varieties -Do not use stem cuttings from the diseased sources
Infestation after internode elongation stage at the age of 5 months onwards till harvest	**Stem borers** *Chilo tumidicostalis* (Hampson) Symptoms and infestation Adult is a dark brown moth, 14.53 to 18.24 mm in length. Eggs are laid resembling fish eggs, with membrane. The eggs are laid under leaves, on leaves, and on stems. Larva body is creamy white similar to Early shoot borers, but the stripe on the sides and top of body are different. Mature larvae are about 19.12 to 23.22 mm long. The hatched larvae crawl to the top of cane away from the egg laying area about one internode. Larvae bore and enter into the stem and cause damage. If the sugarcane	- If the damage caused by larvae is found, immediately cut the infested canes. - If the eggs are found, release parasitoids at the rate of 12,000 to 20,000 per rai. If the larvae are found, release parasitoids at the rate of 500 to 1,000 per rai. If both are not available, release *Proreus simulans* Stallen at the rate of 500 to 1,000 per rai.

Outbreak Period	Major Diseases and Pests	Control Methods
	variety is susceptible to stem borer, the larvae will penetrate the stem and eat the fiber inside leaving the rind intact. For resistant varieties, the first 3 internodes are eaten. Spread of the disease. The infestation is found in all regions. Serious outbreak is in the area of high moisture 70 to 80% near water source or in vicinity of rice field.	
Infestation in most of the vegetative growth, mainly in tillering stage (1-4 months old). The serious outbreak occurs when temperature is high, humidity is low and without rain. The population is low during rainy season or high humidity	**Early shoot borers** *Chilo infuscatellus* Snellen Symptoms and infestation Adult is a brown moth with 13 to 15 mm long. Front wings are dark brown with a faint dark brown spot on each side while the rear wings are light brown. Eggs are laid resembling fish eggs, on top of each others without cover. The egg surface is smooth and white. They are laid on and below leaves. The larvae body is white with short dark brown hair. The base of the hair is dark brown. The patchy dark brown or dark brown and white stripes throughout the body. Mature larvae are about 24 to 26 mm long. Larvae at the first to the second stage will eat sugarcane leaves. Larvae at the third stage will drop down to the ground then eat the sprout causing dry and dead shoots (dead heart). Spread of the disease. The infestation is found in all regions.	- After harvest, mulch with sugarcane leaves to reduce the infestation of early shoot borers. - Cut the infested shoots and slit to destroy the borers. - If the eggs are found, release parasitoids at the rate of 12,000 to 20,000 per rai. If the larvae are found, release parasitoids at the rate of 500 to 1,000 per rai. If both are not available, release *Proreus simulans* Stallen at the rate of 500 to 1,000 per rai.
Throughout the year especially in the planting area of sandy loam soil and prolonged drought conditions.	**Stem boring grub** *Dorysthenes (Lophosternus) bugueti* Guerin. Symptoms and infestation Stem boring grub is a soil pest. Adult is reddish brown color with 25-40 mm long. The female end of abdomen is round while the end of male's is curved with hair beneath thorax. Eggs are laid in soil around the base of canes. Larvae are white throughout, cylindrical-shaped and slightly flat, with small mouth but strong proboscis. The larvae destroy the stem cutting in early stage causing no	- While ploughing, pick up worms along furrows 1-2 times. - At the end of March to the begin of April, Stem boring grub becomes adult, dig a hole to trap adult but place the bottom of the hole with plastic bag to prevent egg laying of Stem boring grub. - Pesticide shall be applied according to the recommendation of the Department of Agriculture

Outbreak Period	Major Diseases and Pests	Control Methods
	germination. The sprout at the age of 1 to 3 months will be destroyed at the base attached to the cutting causing dry and dead sprout. For the destruction of the internode elongation, leaf sheath and leaf will be exceptionally dry until the whole stem or tiller is dead. Spread of the disease The infestation is found in sandy loam soil.	
Serious outbreak is in dry weather, prolonged drought conditions.	**Termite** Symptoms and infestation The body of termite is white, with rather round brown head. Some types of sugarcane termite are important e.g. a group of under ground living tunnel. Termites, a group of social insects, comprise of workers responsible for finding food, soldiers responsible for defending enemy. Only breeders have wings. They can fly to mate and build a new hill. They start to destroy from planted stem cutting, gain entry through the cut ends. In the internode elongation stage, termites attack slightly below soil surface and feed on the inner tissue and go up to make hollow cane. The hollow will be filled with soil. When there is more destruction of termites, breaking and falling of canes are observed. Spread of the disease The infestation is found in all regions.	- The prevention should be started at planting. Plowing several times before planting shall destroy termite hills and help birds and ants easily feed on termites. - Use pesticide according to the recommendation of the Department of Agriculture.
Throughout the year especially in the planting area of sandy loam soil.	**White grub** Symptoms and infestation Scarab beetle is soil pest. An adult is rather large with hard-shelled body of about 32-40 mm long. Eggs are laid at 15 cm depth into the soil. Larvae are white throughout the body and curved (C-shaped). Its skull is brown, big and strong. A mouth has strong and big fang Legs are obvious but rarely used. Mature larvae are 65-70 mm long. Larvae feed on sugarcane roots. The whole canes will be dry and dead. The infested canes are easily pulled out from the ground because all of roots are destroyed.	- Collect adults by hands to kill or to cook as food helps reduce the number of insects. -Before planting, plow soil several times to destroy eggs and larvae. - Use pesticide according to the recommendation of the Department of Agriculture.

Outbreak Period	Major Diseases and Pests	Control Methods
	Spread of the disease The infestation is found in planting area with sandy loam soil.	
Serious outbreak in rainy season during May to October.	**Sugarcane leaf-hopper** *Matsumuratettix hiroglyphicus* Symptoms and infestation sugarcane leaf-hopper are the carriers of white leaf disease. They suck sap from the infected sugarcane, infected and multiplied in stomach. The grasshoppers can transmit the disease to normal sugarcanes throughout their life cycle. Male is light brown, with pale green abdomen. There are spots without order on the wings. Female are dark brown with greener abdomen than male. There are spots scattered on the wings. Eggs are laid one by one. Freshly laid eggs are clear white then changed to opaque white. Eggs are laid in soil.	- Do not use stem cuttings from the diseased sources and planting area. - In the area of regular outbreak, destroy the plant stubbles after harvest. - Use crop rotation to cut disease cycle such as angola pea, jack bean, soybean, and corn.

APPENDIX C

GUIDANCE ON THE PRODUCTION OF SUGARCANE STEM CUTTINGS

(Section A.3.2.3)

The objective of sugarcane stem cutting production is to provide pure, of the required and consistent variety without other varieties mixed. The good stem cutting production will enhance the variety which is healthy and free from pest which can reduce the infection of the diseases and insects. The recommendations should be considered as follows:

C.1 Location

- Soil condition: topsoil shall be deep, loamy, well ventilated and well drained, highly fertile and in proper pH range.

- Water source: water should be sufficient throughout the planting season or production should be established in the irrigated area or closed to natural water resources.

- Land use history: the land has never had outbreak on sugarcane disease because there may be disease left on the land causing infection. In addition, sugarcanes have been planted on such land, it is necessary to clear all ratoons to avoid other varieties.

C.2 Planting Materials and Preparation

- Varieties suitable to each location, resistant, or according to the recommendation of the government or related agencies or the sugarcane breeder should be used.

- Age of the stem cuttings should be at 8-10 months and come from plant cane because the use of ratoon often accumulate the disease particularly White leaf.

- Stem cutting should be selected from the plot which has a good vegetative growth, complete tiller, free from pest. Stem cutting with healthy bud should be selected. The bud covered with leaf sheathes will decelerate the germination and the germinating bud should be cut off.

- Each stem cutting should contain two to three buds. Dip the cutting in the 50^{o}c water for 2 hours to prevent disease and insect in contact with the cutting and immediately plant. In case there is risk of Smut, Red rot, and Pineapple disease in the area, dip the cuttings in the water solution of Triadimefonthen 40 g/20 L or Propiconazol 16 ml/20 L for 30 minutes.

C.3 Planting and tending

- Plan in advance on production of stem cuttings in order to provide the cuttings at proper period of planting.

- Place two prepared stem cuttings at the spacing of 50 cm along the row, cover with soil and water immediately.

- Pest control is done in the same manner as practices for general cane production.

- Fertilizer is done in the same manner as practices for general cane production and 1 month before harvesting, 30 to 40 kg per rai of Nitrogen should be applied to accelerate the germination of stem cutting.

- Inspection shall be regularly practiced or at least three times as follows:

At the age of 1 month, check the percentage of germination, replant and dispose of ratoons from previous season.

At the age of 3 months, check for other undesired varieties.

At the age of 7-8 months, check pest infestation and cane health before use as stem cutting.

C.4 Harvest

- Use knife to cut leaves from bottom to top without removing sheath in order to avoid bud injury.

- Carefully bundle stem cutting to prevent bud injury and deliver to the planting area.

APPENDIX D

UNITS

The units and symbols used in this standard and the units recognized by the International System of units (*Le Système International d' Unités*) or SI are as follows:

Type of Measurement	Name of Unit	Symbol
Length	millimetre	mm
	centimetre	cm
Temperature	degree Celsius	C