Outcomes and Findings of CSAM Integrated Straw Management Research

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UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

CSAM

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  Professor, China Agricultural University

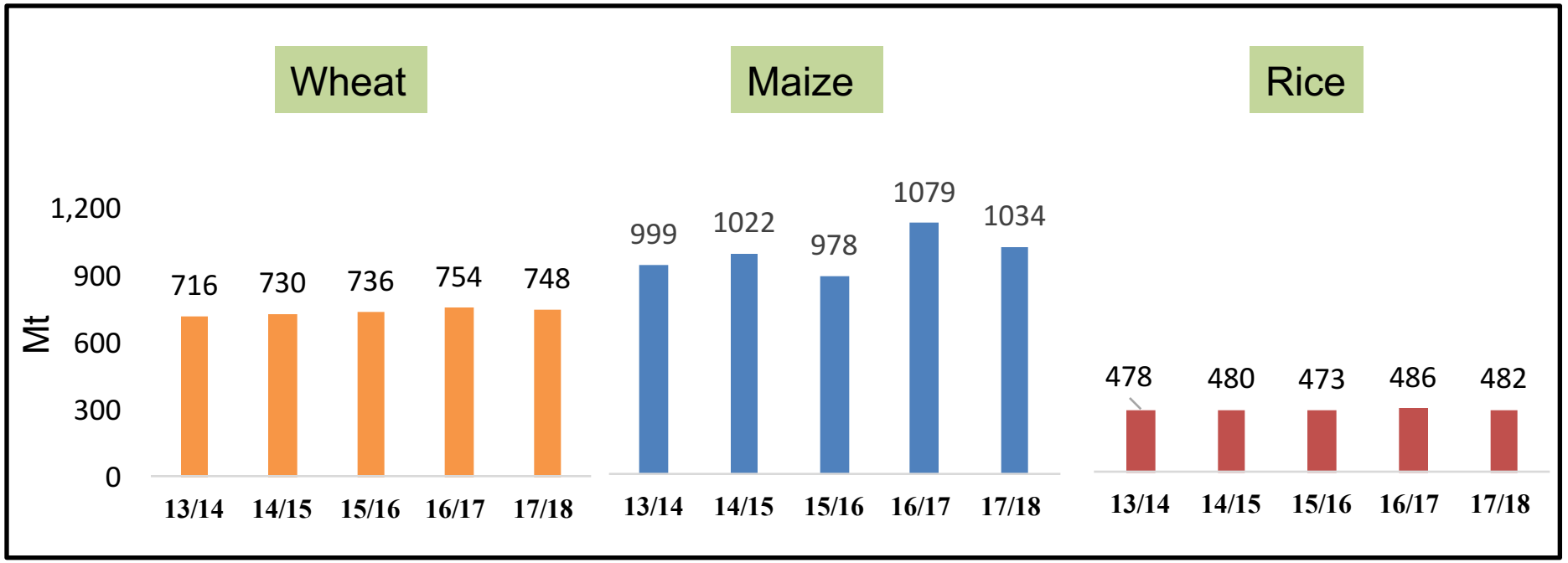
And ……..

CONTENTS

1. Background
2. Status of crop straw resources
3. Straw management patterns and benefit
4. Research and demonstration

Section I :
Background

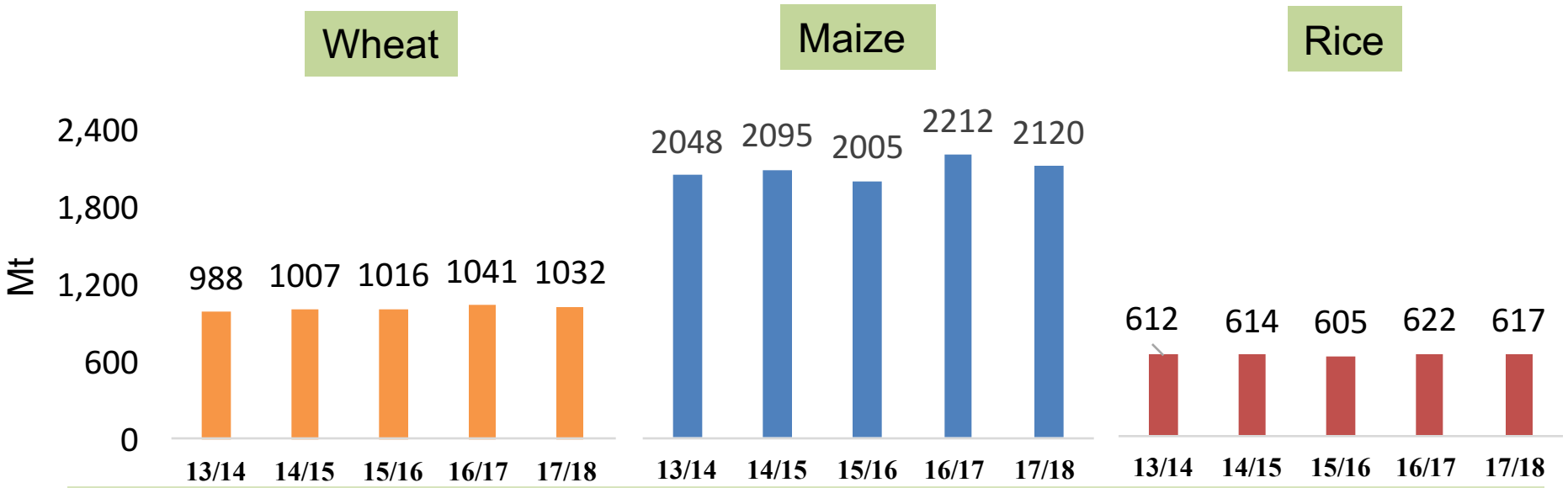
1.World main cereal production



Source：International Grains Council, 2017
16/17 estimated, 17/18 forecast

- **The world produces 2.8 billion tons of cereals** *(FAO,2014)*
- **The maximum three cereals are maize, wheat, rice**

2.Straw yield of three main cereals (in the world)



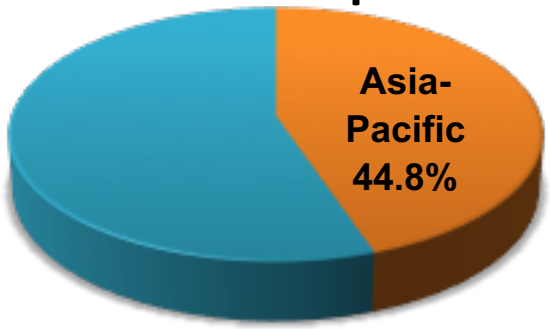
Source： International Grains Council, 2017

Straw yield was calculated by the ratio of straw-grain: wheat-1.38; maize-2.05; rice-1.28

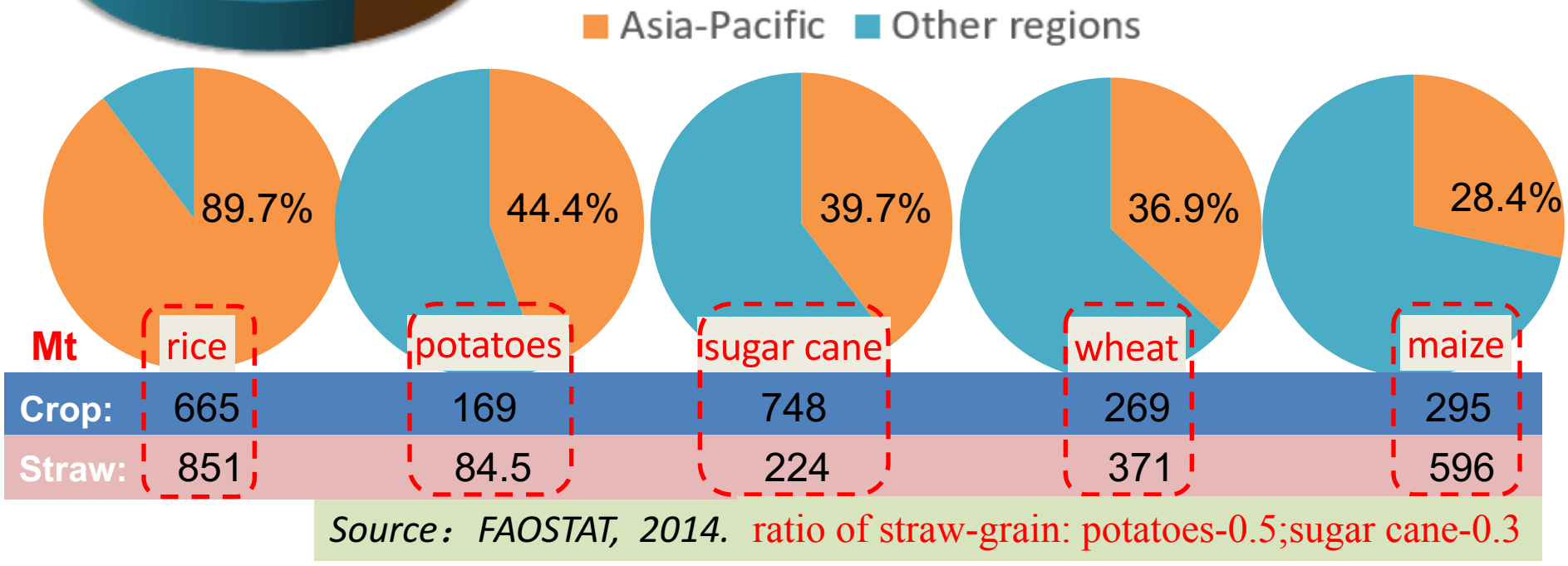
Enormous cereals produces enormous straw

3.Straw yield of five main crops (in Asia & Pacific)

World cereal production



Asia-Pacific is one of the largest cereal production region (44.8%)



Source：FAOSTAT, 2014. ratio of straw-grain: potatoes-0.5;sugar cane-0.3

Huge amounts of straw in Asia-Pacific, 2126.5Mt (calculated) of the major 5 crops!

How to deal with such a large amount of straw is the great challenge in Asia Pacific!!!

4.Straw burning in Asia-Pacific

Impacts of straw burning

Loss of nutrients

Fire disaster

Environment pollution

Traffic accident

Resource usage straw burning Troubles

5.The 4th Regional Forum on Sustainable Agricultural Mechanization in Asia and the Pacific

- Promote climate-smart agriculture/agricultural mechanization
- A new initiative on Integrated Straw Management to address the shared issue of straw burning

Objectives

- Understand current situation of crop straw resources; collect available and proven practices/technologies of straw management
- Design an action plan for pilot interventions of integrated straw management in selected member countries; and
- Identify requirements, and recommend appropriate pilot sites and partners

Section Ⅱ:

Status of Crop Straw Resources in Asia-Pacific

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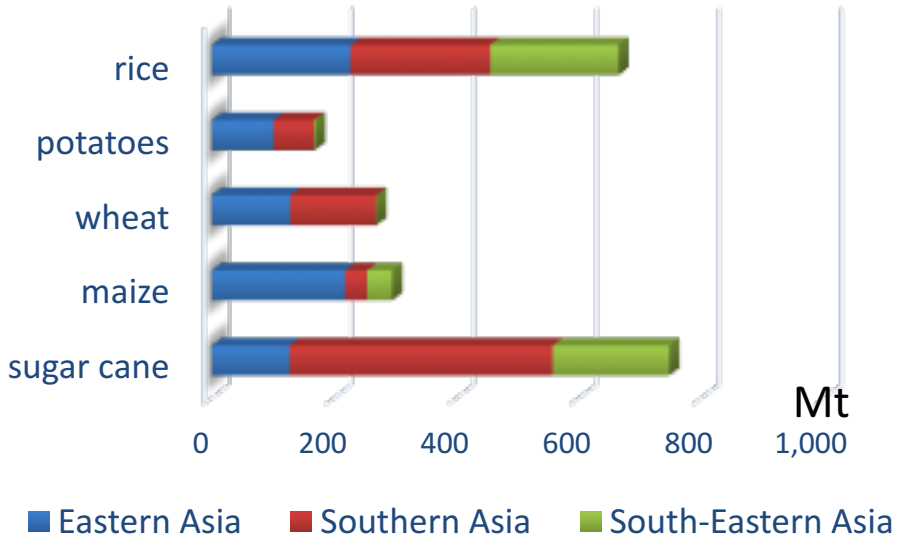
1. Types of crop straw

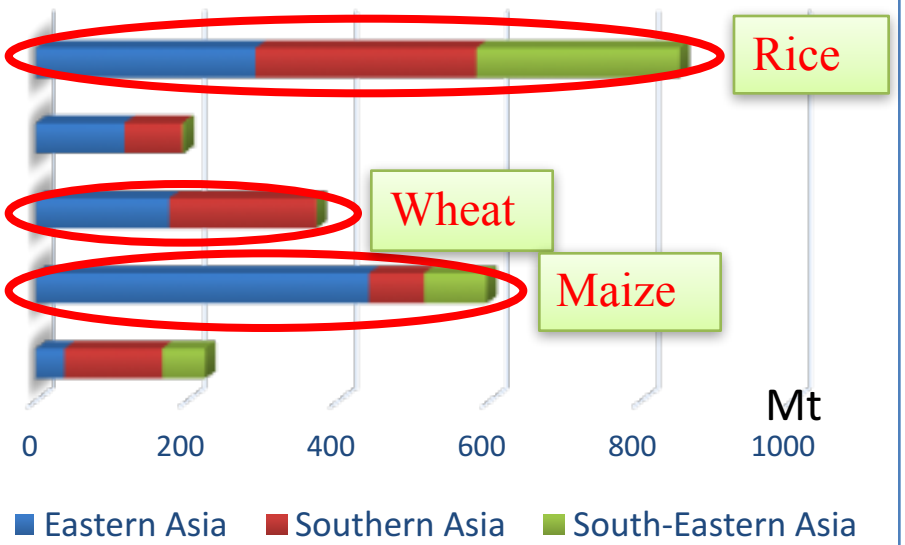
Grain crop straw	 maize	 wheat	 rice	 barley	 oat
Oil crop straw	 sunflower	 rape	 peanut	 bean	 sesame
Fiber crop straw	 cotton	 ramie	 linen	 kenaf	 jute
Other crop straw	 sugar cane	 flue-cured tobacco	 sugar beet		

2.Straw yield in East, South and Southeast Asia

Crop production



Straw production



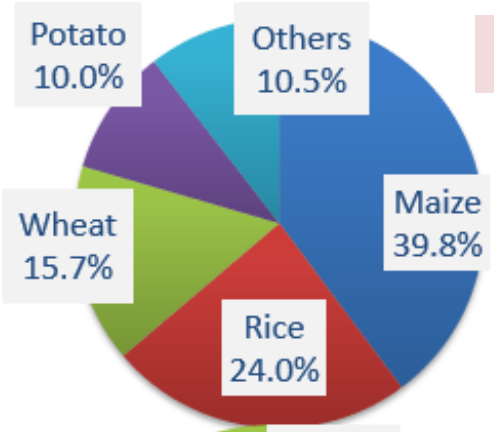
Source：FAOSTAT, 2014

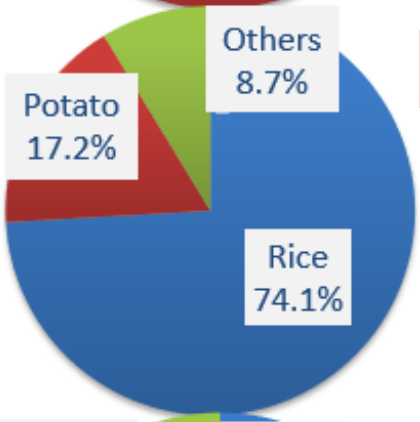
Top 3 straw crops in Asia-Pacific: Rice, Maize, Wheat

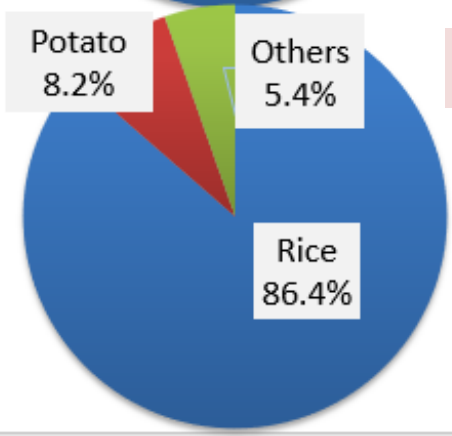
3.Crop straw distribution (East Asia)

Wheat Potato Rice

maize cotton







Source： FAOSTAT, 2014

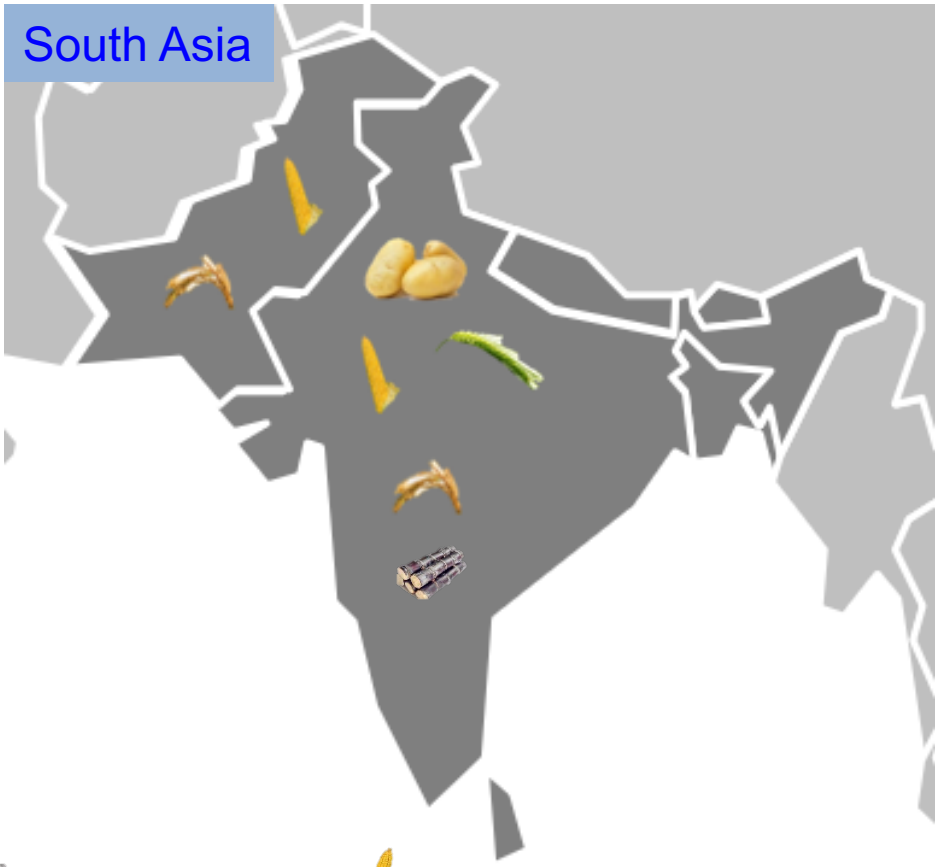
Crop straw yield (Mt) in East Asia

Crop	Straw-grain ratio	China		Japan		KOR	
		Grain	Straw	Grain	Straw	Grain	Straw
Rice	1.28	208.24	266.55	10.55	13.50	5.64	7.22
Wheat	1.38	126.22	174.18	0.85	1.18	/	/
Maize	2.05	215.81	442.41	0.25	0.51	/	/
Potato	1.16	95.57	110.86	2.46	2.85	0.59	0.69

Source： FAOSTAT, 2014

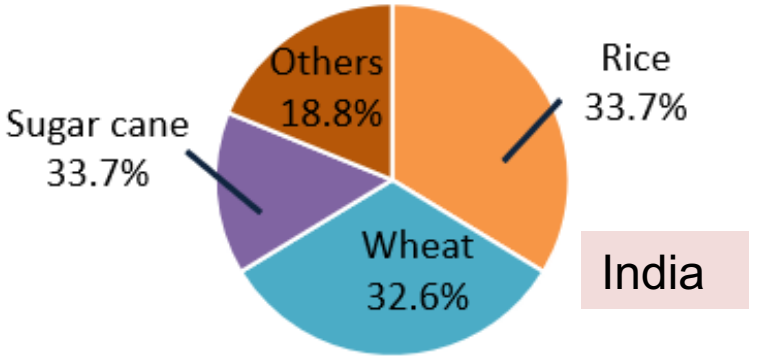
- **China produces maximum straw in East Asia**
- **Rice straw is the main straw in Japan and KOR**

3.Crop straw distribution (South Asia)

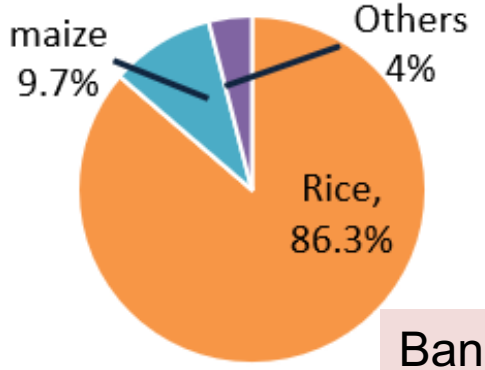


Sugarcane Maize

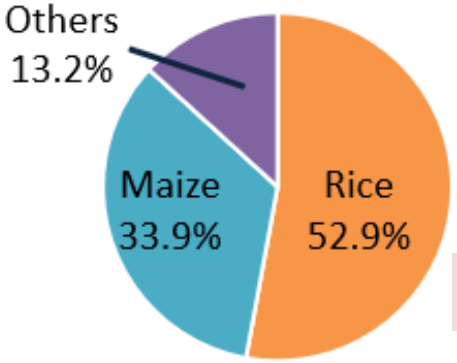
Wheat Potato Rice



India



Bangladesh



Nepal

Source： FAOSTAT, 2014

Crop straw yield (Mt) in South Asia

Crop	Straw-grain ratio	India		Bangladesh		Nepal		Shri Lanka	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Rice	1.28	108.8	139.26	34.57	44.25	4.95	6.33	4.50	5.76
Wheat	1.38	96.6	133.30	1.30	1.79	1.57	2.16	/	/
Maize	2.05	26.15	53.60	2.75	5.63	2.20	4.50	0.24	0.48

Source：FAOSTAT, 2014

- **India produces maximum straw in South Asia**
- **Rice straw is the main straw in South Asia**

3.Crop straw distribution (Southeast Asia)

- **Rice and maize straw are the two main crop straws.**
- **Wheat is mainly in the Northern parts, Myanmar and Northern of Thailand**

Source： Bakker et al, 2013

Crop straw yield (Mt) in Southeast Asia

Crop	Straw-grain ratio	Indonesia		Vietnam		Myanmar		Thailand	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Rice	1.28	70.84	90.68	44.07	49.59	26.42	33.82	32.62	41.75
Wheat	1.38	-	-	-	-	0.186	0.256	0.0015	0.00028
Maize	2.05	18.51	37.94	5.19	10.64	1.60	3.28	4.87	9.98

(Source: FAOSTAT, 2014); a : Statistical Yearbook of Vietnam 2013; b Diep Quynh Nhu, 2014

- **Indonesia 90.68Mt/yr (Rice), much more than other Southeast Asia countries**
- **Total amount of rice straw was about 210.10Mt/yr.**

Section Ⅲ:

Crop Straw Management Patterns and Benefits

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1.Fertilizer

2.Fodder

3.New energy resources

Integrated Straw Management

4.Base stock

5.Industry material

Selection principles of straw management

◆Availabilities of technologies

①Advanced ②Mature ③Reliable stability

◆ Matched conditions in the region

①Equipment ②Machines ③Land

◆ Adaptation of technologies

①Current situation ②Characteristics

③Development requirement

◆ Adaptation of technologies

①Reduce cost②Environment-friendly

1.Used as fertilizer

① Soil cover

Harvest ⇨ Straws chopping and mulching ⇨ No-till seeding

② Mix-buried with soil

Harvest ⇨ Straw chopping and spreading ⇨ Straw burying by roto-till/harrow

③ Pre-decomposed straw returning



Harvest ⇨ Adding decomposition agent ⇨ Composting ⇨ Returning to field

④ Carbonized straw returning



Straw collection ⇨ Carbonization ⇨ Slow release fertilizer ⇨ Returning to field

Status for straw used as fertilizer

Area	County	Major used crop straw	Ratio	Technology
East Asia	China	Maize, Wheat, Rice	43.2%	Straw directly returning to field, Straw indirectly returning to field
	Japan	Rice, Wheat	55.0%	Straw directly returning to field, Decomposed straw returning
	KOR	Rice	45.7%	Straw directly returning to field
South Asia	India	Rice	15-20%	Straw directly returning to field
Southeast Asia	Vietnam	Rice	26.1%	Straw directly returning to field
	Philippines	Rice	29.7-40.2%	Straw directly returning to field
	Thailand	Rice, Maize	35.3%a	Straw directly returning to field

East Asia →About 43% of the crop straw was returned to the field

South Asia →Straw was poorly utilized for fertilizer

Southeast Asia →Returned directly to the soil by plough/roto-till

2.Used as fodder

① Ensilage

Harvest ⇨ Chopping and adding additive ⇨ Bagging

② Silken straw fodder

Dry straw ⇨ Kneading and bundling ⇨ Bagging

③ Briquetting

Chopping ⇨ Drying ⇨ Compression molding

④ Ammoniation treatment

Chopping ⇨ Mix with ammonia sources ⇨ Sealing treatment

Status for straw used as fodder

Area	Country	Ratio	Major used crops straws	Technology
East Asia	China	18.8%	Maize, rice	Ensilage and coarse fodder
	Japan	10.3%	Rice	Coarse fodder
	KOR	20.8%	Rice	Ensilage
South Asia	India	/	Rice, maize, wheat	Ensilage and coarse fodder
Southeast Asia	Indonesia	31%	Rice	Ensilage and coarse fodder
	Vietnam	23%	Rice	Coarse fodder
	Thailand	15%	Rice	Ensilage and coarse fodder
	Philippines	2-4%	Rice	Coarse fodder

East Asia →Applied well, but still, with a need for potentiality exploitation

South Asia →Wheat straw and chopped maize stalk are the most favored fodder

Southeast Asia →Raw rice straw was used popularly for animal feed

3.Used as new energy resource

① Briquette fuel

Raw material ⇨ Smash and briquette ⇨ Warehousing and using

② Biogas production

Raw material ⇨ Stack retting and fermentation ⇨ Produce biogas

③ carbonization fuel

Raw material ⇨ Carbonization ⇨ Pulverize ⇨ Carbon dust

④ gasification fuel

Straw and air ⇨ Gasifier and scrubber ⇨ Separator ⇨ Gas tank

⑤ degradation and ethanol production

Pretreatment of raw material ⇨ Saccharification ⇨ Fermentation ⇨ Distill

Status for straw used as new energy resource

Area	Country	Ratio	Major used crops straws	Technology
East Asia	China	11.4%	Maize, rice	Fuel
	Japan	/	Rice	Degraded into ethanol
South Asia	India	2-4%	Rice	Biomass briquettes
Southeast Asia	Vietnam	0.36%	Rice	Ensilage
	Indonesia	25%	Rice	Fuel production
	Thailand	0.2%	Rice	Fuel production

East Asia →Biogas and briquette fuel have been greatly developed

South Asia →Decrease, due to cheaper option of solar power generation projects

Southeast Asia →Biofuel from residues could displace all fuel used for transport

4.Used as base stock

Cultivating fungi

House construction and material reserving ⇨

Composting and fermentation ⇨ Planting ⇨

Fungi management ⇨ Harvest

Status for straw used as base stock

Area	Country	Ratio	Major used crops straws	Technology
East Asia	China	4%	Maize, rice	Cultivating fungi
South Asia	India	-	Rice	Cultivating fungi
Southeast Asia	Vietnam	-	Rice, maize	Bedding materials for cattle houses

East Asia → Only accounted for a small fraction of all crop straw

South Asia → The quantity straw used for this purpose is almost negligible as compared to its production

Southeast Asia → Not much popular

5.Used as industry material

① Papermaking



Infiltration and calcify ⇨ Straw pulp ⇨ Molding and incision ⇨ Package and products

② Sheet production


Smash ⇨ Roller-compaction ⇨ Maintenance ⇨ Package

③ Crafts production



Collecting high quality straw ⇨ Manually flattening straw ⇨ Framing

④ Xylitol production


Raw material ⇨ Hydrolysis and hydrogenation ⇨ Concentrate and crystallize ⇨ Crystalline xylitol

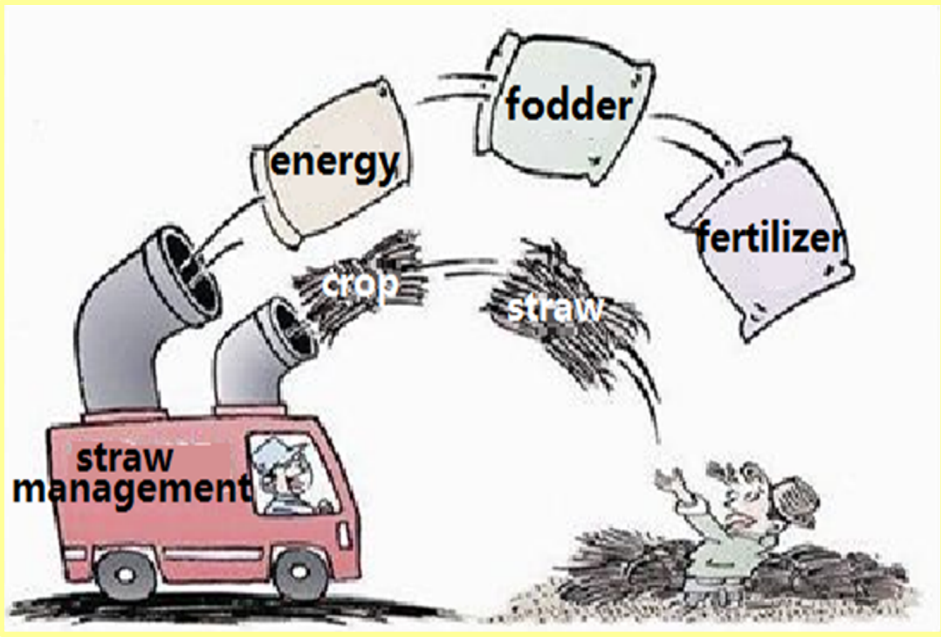
Status for straw used as industry material

East Asia →China is the largest straw pulp making country, and the straw pulp can occupy 33.95% of total paper pulp in the country

South Asia →About 30% of India's paper is made from agricultural residue and/or non-wood fibers

Southeast Asia →Rice straw is used as raw material for industry in Indonesia is about 7%

Beneficial impacts (Social benefits)



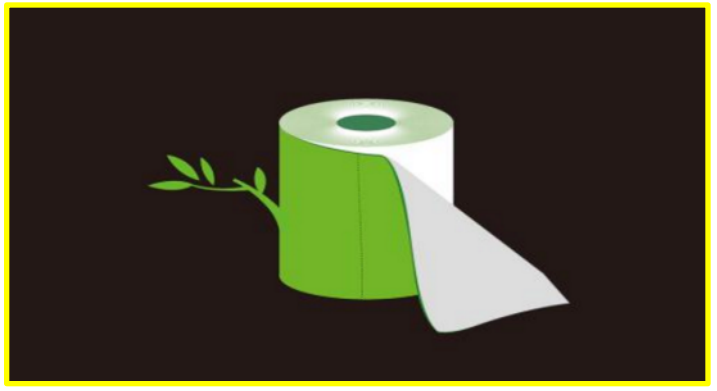
- Broaden the channel of straw resource utilization
- Adapts the new requirements of beautiful livable rural construction

Beneficial impacts (Ecological benefits)

➢Reduce soil erosion and improve soil structure

➢Protect environment and reduce greenhouse gas emissions

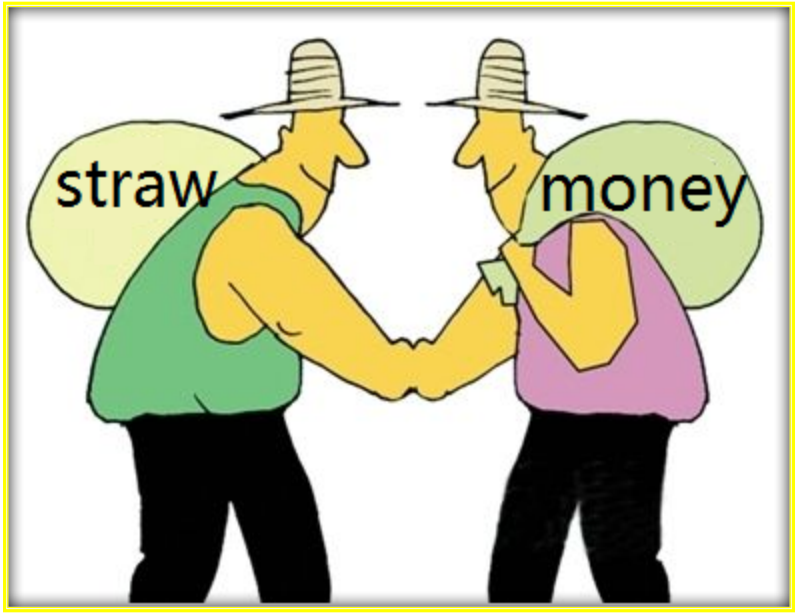
➢Replace non-renewable resources



➢Protect forest resource

Beneficial impacts (Economic benefits)

✓Achieve multiple value-added income



✓Save agricultural cost and invest

➢**Promote the development of agriculture and rural economy**

Section Ⅳ:

Research and Demonstration

(For selected options of Integrated Straw Management)

1. Scientific research

- Machines and Equipments
- Technical modes

- Soil and Crop
- Animal
- Social, economic and ecological effects
- ……

Effects

2. Demonstration

Selection principles of partners and sites

◆Cooperative partners

①Staffs and facilities

②Scientific ability

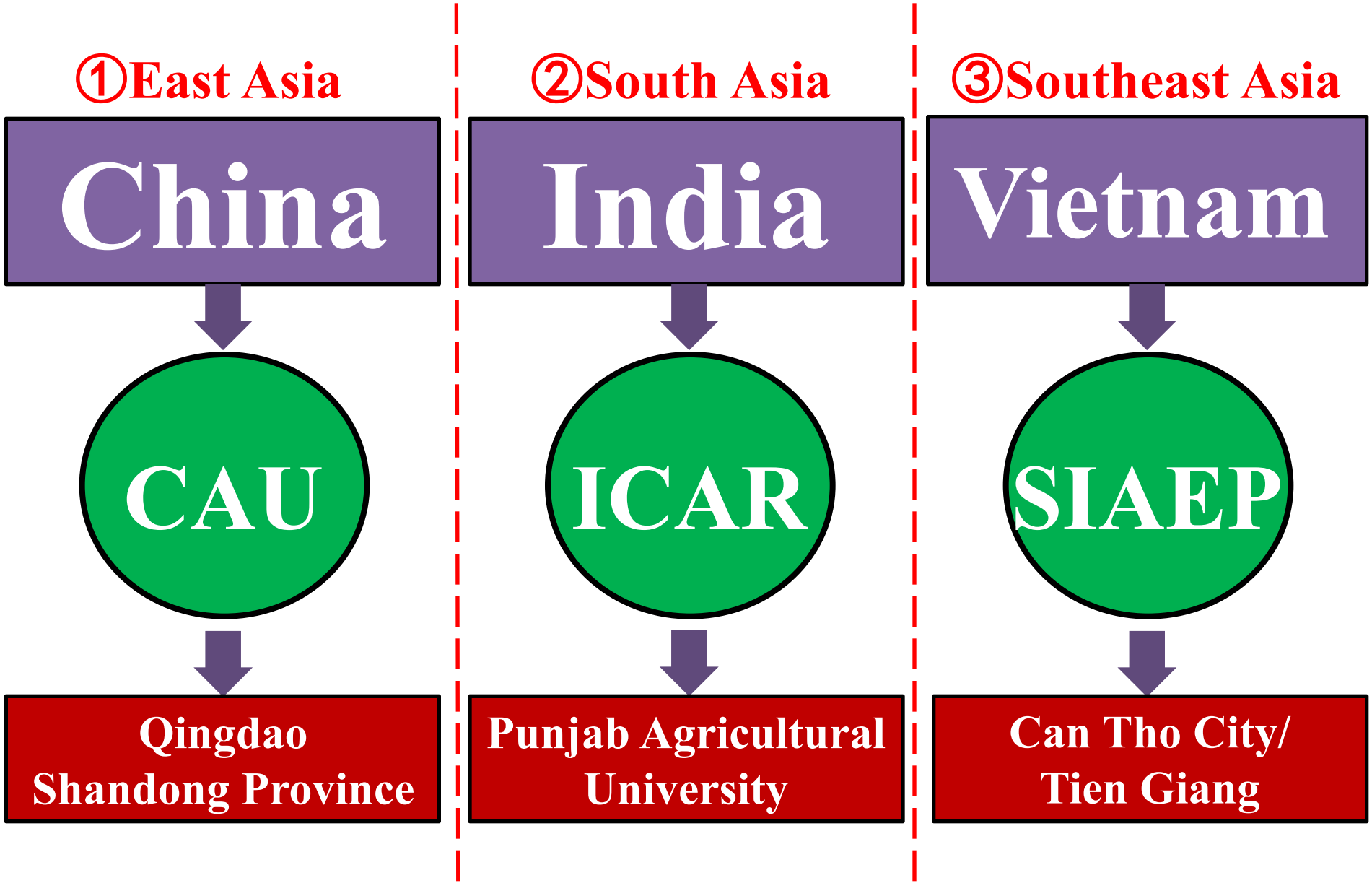
◆Pilot sites

①Good facilities

②Good conditions for training

③Large areas for demonstration

Recommended partners and pilot sites

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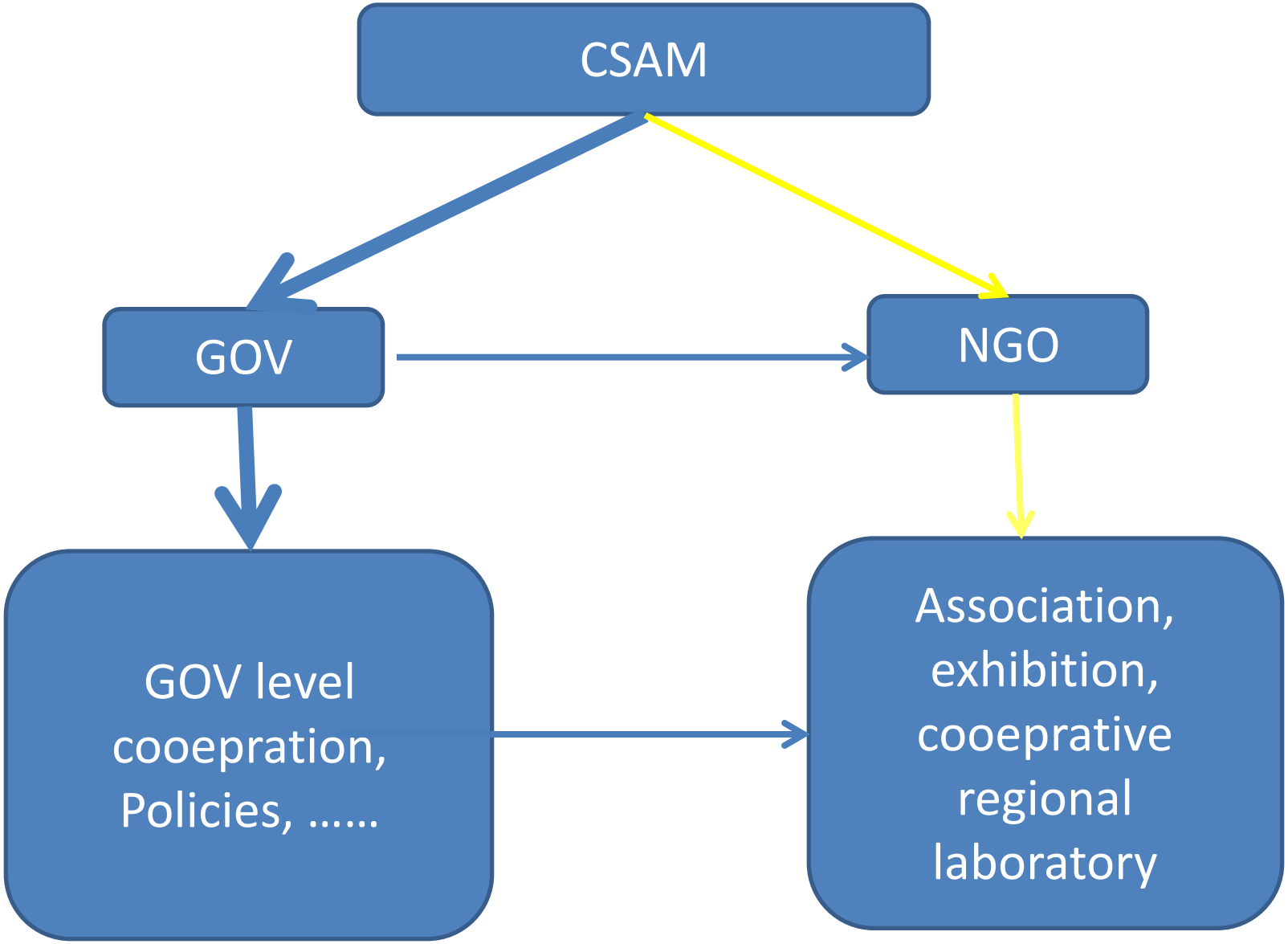
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