Agricultural methods of alleviating sediment runoff in the case of red-soil erosion and runoff problem in Okinawa

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Red-soil problem in Okinawa 1

Since 1970's farmland improvement and infrastructure construction
Land use: forest →farmland

←subtropical climate (big rainfall intensity, typhoon)
←acid soil (easily eroded)
←big slope angle (～14%)

Soil erosion and runoff


Sugarcane field soon after planting


Gully erosion on bare land

Red-soil problem in Okinawa 2

Soil erosion and runoff from farmland

↓

Flow down through channel and river

↓ → short river (5–10km)
→ into the see in short time

Accumulate and deposit in the reef

→ damage on ecological system
(coral, fish etc.)

Especially coral have serious damage

No effect of red-soil

Only few kinds

died out

Sediment runoff alleviating methods

infrastructural・・・drainage, settling basin, etc.

→ High cost
Erosion in the farmland cannot be alleviated

agricultural・・・grass strips, malting, no-tillage planting, etc

→ Expected to evaluate **Effectiveness**
Effects on products

Purpose of the presentation

By Field test

To examine the difference of the amount of sediment runoff between various conventional cultivating ways of sugarcane

To verify quantitatively runoff reduction effects and crop yields

Alleviating sediment runoff methods

--Grass strips

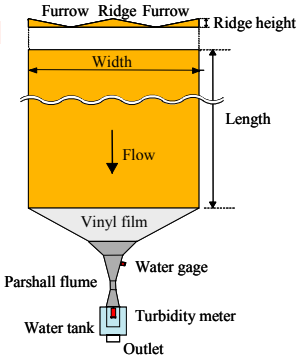
--Partial tillage planting and Intercropping

Field location

Outline of the test plots

Plots are set in the actual sugarcane field

Slope length:85m angle:3.5%

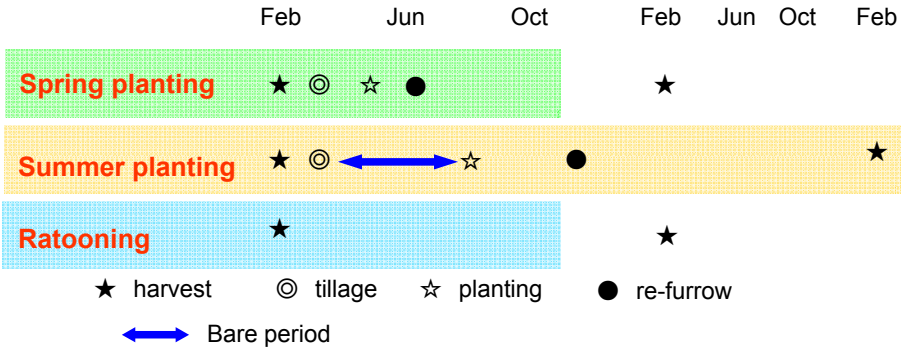


Particle size distribution (the surface soil)(%)

clay	silt	sand	gravel
5	19	32	44

Conventional cultivating ways of sugarcane

Conventional cultivating ways of sugarcane



Ratooning made only after spring/summer planting

tillage

planting

harvest

Test schedule

Test period・・・June.2004～February.2007

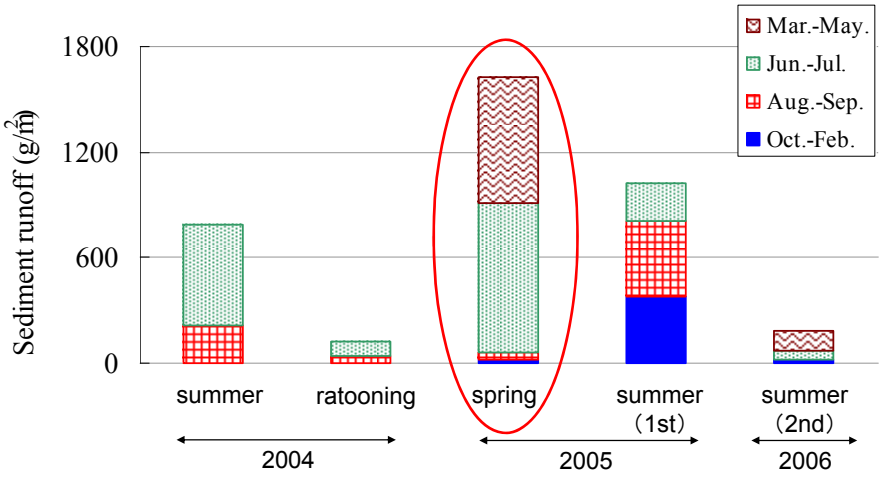
year	cultivating way		
2004	spring planting	ratooning	
2005	spring planting		summer planting (1st)
2006			summer planting (2nd)

Spring planting was made twice (2004 and 2005)

Summer planting was made once for two years (2005 to 2006)

Spring planting ⟶ spring
Summer planting ⟶ summer

Result : sediment runoff



Ratooning 120 $gm^{-2}yr^{-1}$, much less than the others
as much yield as spring planting (high-yield)
can be made only after spring or summer

Alleviating methods for spring planting is needed

Alleviating methods for spring planting

Two methods tested

Grass strips — set up on the edge of the downstream

Partial tillage planting and Intercropping — considering seasonal characteristics of sediment runoff, two methods applied on one cultivation

Grass strips

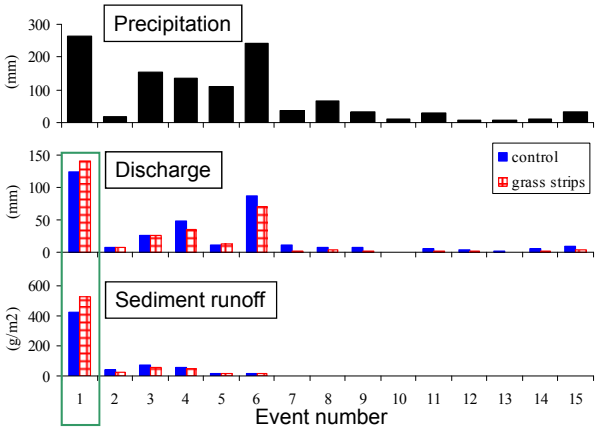
Field photo (grass strips)

control

（soon after setting up）

grass strips

Result 1 : sum for each event



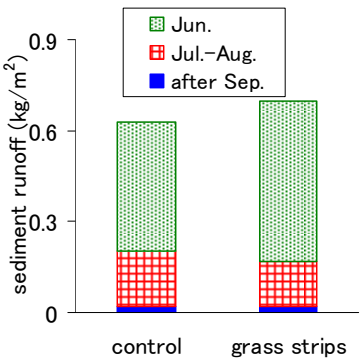
Event number

1/ Jun.8-10	9/ Dec.2-4
2/ Aug.3	10/ Dec.20
3/ Aug11-12	11/ Dec.24
4/ Aug.17-18	12/ Dec.25-26
5/ Aug.23	13/ Dec.28-29
6/ Sep.9-15	14/ Jan.8-9
7/ Sep.26-27	15/ Jan.13-14
8/ Oct.17-19	

event.1 grass strips was larger
--because it was soon after the grass strips were set up

The others grass strips was less by a little

Result 2 : sum for test period



Jun. Grass strips was larger because it was soon after set up
soil jumbled → easily runoff

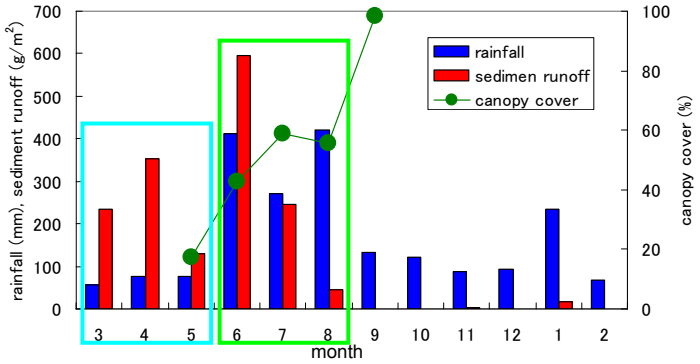
The others grass strips was less only by 17%

Grass strips is not so effective to alleviating sediment runoff

Partial tillage planting
and
Intercropping

Seasonal characteristics of sediment runoff

Monthly Sediment runoff, rainfall and canopy cover (on spring planting, 2005)

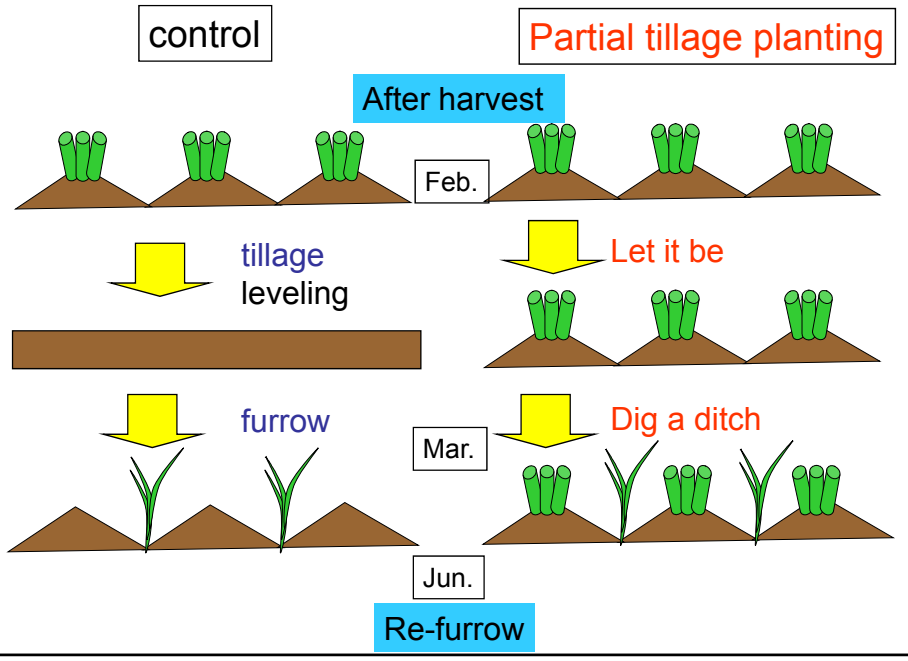


In growing period and rainy period much sediment runoff

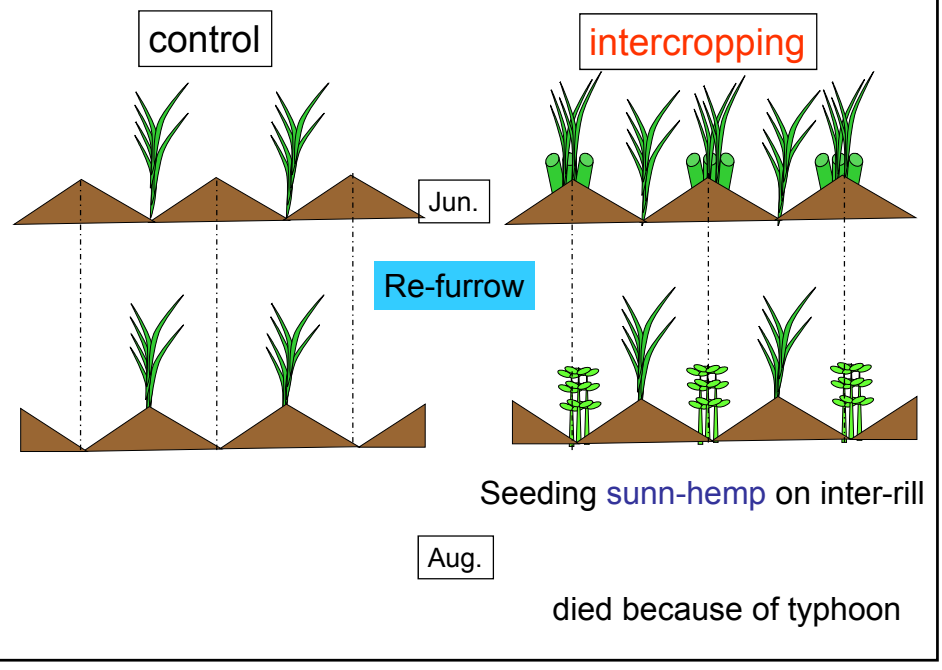
Growing period — Partial tillage planting

Rainy period — Intercropping

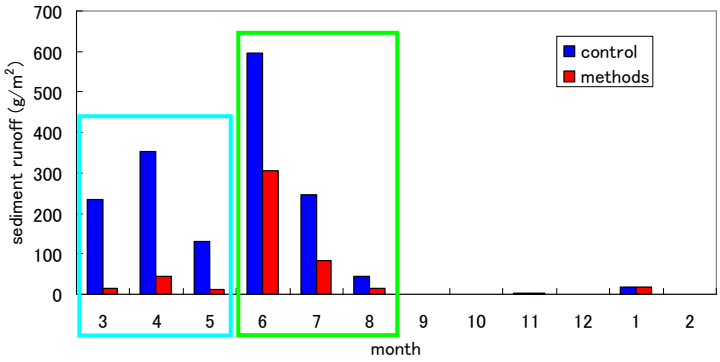
Partial tillage planting



Intercropping



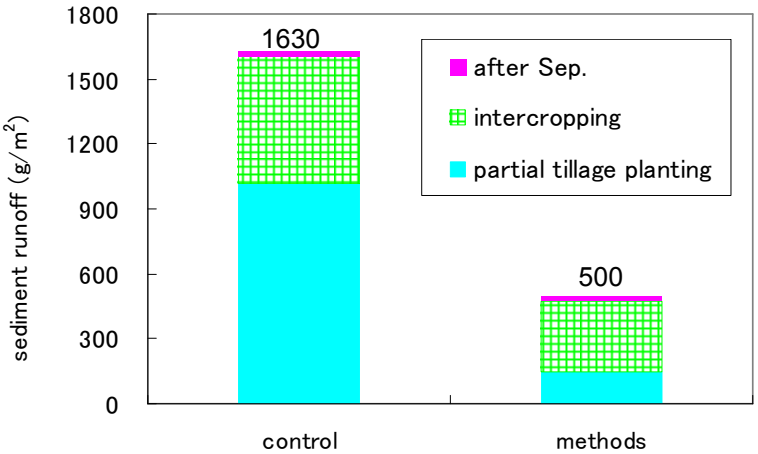
Result 1 : sum for each month



Partial tillage planting → 89% reduction

Intercropping → 45% reduction

Result 2 : sum for test period



Sediment runoff — 71% reduction

Crop yield — 36% decrease

Conclusion

Conventional cultivating ways of sugarcane

Ratooning

much less sediment runoff than spring/summer planting

can be made only after spring/summer planting

Alleviating methods for spring planting

Grass strips

only 17% reduction of sediment runoff (not so effective)

Partial tillage planting and Intercropping

76% reduction of sediment runoff (very effective)

36% decrease of crop yield

	2004		2005		2006
	春植え	株出し	春植え	夏植え(1st)	夏植え(2nd)
Mar.-May.	No data	No data	720	No data	119
Jun.-Jul.	578	81	842	213	49
Aug.-Sep.	214	41	46	427	3
Oct.-Feb.	0	2	20	381	16
Total	793	124	1628	1021	67

土砂流出量②

	2004		2005		2006
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春植え　6月以降　793g/m^2(2004)　866g/m^2(2005)　→　差は10%以下

既往の研究（塩野ら、2007）　春植えの年間土砂流出量：1830g/m^2

年間土砂流出量　春植え：1630g/m^2　夏植え：620g/m^2(平均)　株出し：120g/m^2

株出しは他の2つに比べ80%以上少ない
収量は春植えとほぼ同じ　⇒　望ましい

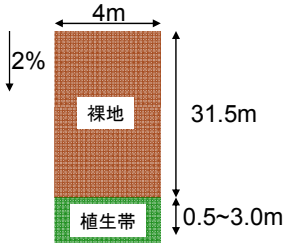
数年に1度は新しく苗を植える（春植え、夏植え）必要

春植え　サトウキビが十分に生長する9月以前に95%以上が集中

夏植え　植え付け前の裸地状態（17%）、
サトウキビが十分に生長する2年目5月以前（79%）に集中

植生帯の有無・・・既往の研究

「耕土流出防止対策の効果について」玉城，中島，塩野（2006）



植生帯（センチピード）による土砂流出削減率

植生帯幅　0.5m：24%
1.5m：38%～51%
3.0m：64%

植生帯の効果は降雨状況により異なる

粒径が0.02mm以上に対しては土砂流出抑制効果が大きい

←植生帯の効果は表流水の流速低下に伴う土砂の沈降と堆積（塩野ら，2005）

土砂発生源が裸地(耕起後そのまま)⇒　耕作条件では??

土砂留めマスによる測定 ⇒ 流出特性の時間変化について考察できない

植生帯の有無・・・試験条件

試験期間　2004年6月～2005年1月

期間中の降雨イベントは15回

試験区

- 慣行栽培区　・・・サトウキビ春植え栽培
- 植生帯設置区・・・サトウキビ春植え栽培＋植生帯（高麗芝）
  植生帯は試験区下流端に幅60cmで設置

	Length(m)	Width(m)	Slope(%)	Ridge height(m)
慣行栽培区	81	2.9	3.5	0.09→0.16
植生帯設置区	76	2.9	3.5	0.08→0.17

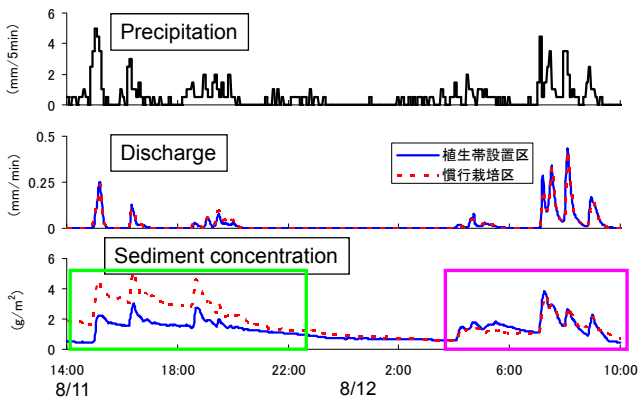
2004年6月23日に培土（畝立て）を行なったため、畝高さは変更された

result (grass strips) ②

降雨イベント8/11~12　総降水量：153.5mm　最大15分間降水量：14mm

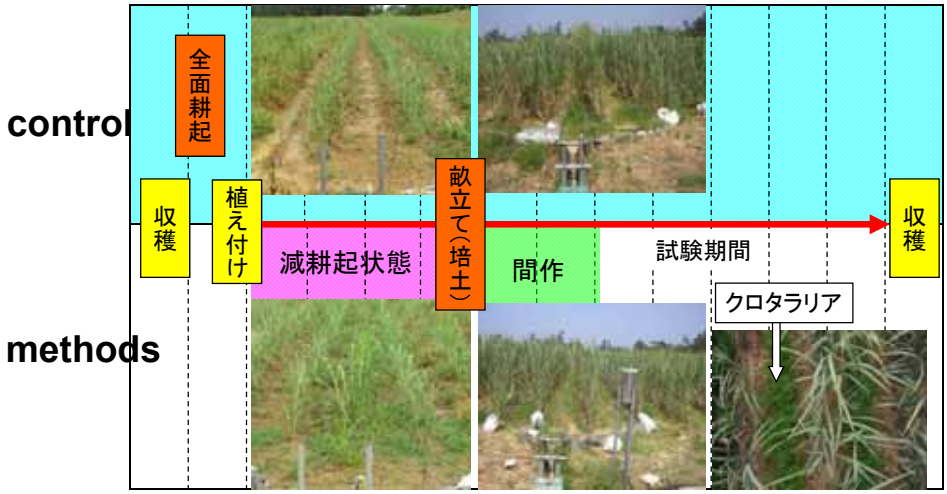
	総流出高(mm)	流出率(%)	流出土砂量(g/m^2)
慣行栽培区	26	17	68
植生帯設置区	26	17	58

-15%



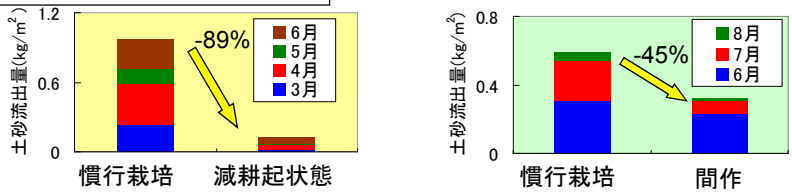
schedule

control
Methods ・・・partial tillage planting＋intercropping

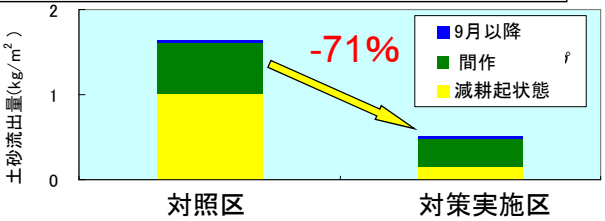


流出土砂量

対策期間ごとの土砂流出量



試験期間（2005年2月～2006年2月）の土砂流出総量



減耕起植え付け
カバークロップ
→ 土砂流出を71%抑制
収量は36%の減収

生産性に課題