



Farming meets solar power in Africa

December 10, 2020
9:00am–10:15am Mali time
Webinar by Zoom

Agrivoltaics for small-scale farmers

It's a promising solution for the difficulties facing



Masa Shigeie

Waku-waku Solar Sharing Farm
Hiroshima, Japan <http://wakumcafe.com>

We're small but typical rice growing farmhouse located in between plains and mountains in Japan

Our village community facing several typical difficulties of Japan

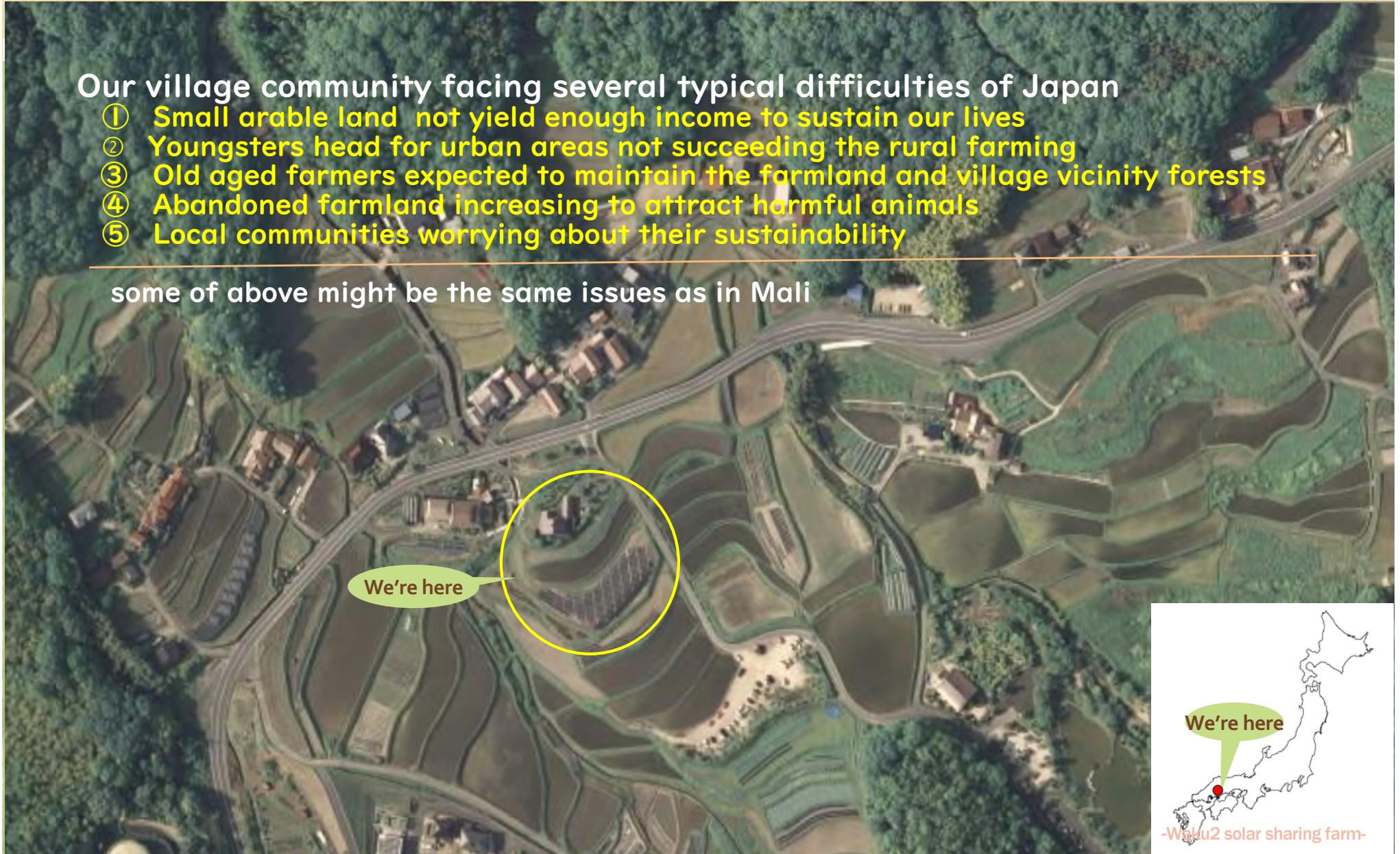
- ① Small arable land not yield enough income to sustain our lives
- ② Youngsters head for urban areas not succeeding the rural farming
- ③ Old aged farmers expected to maintain the farmland and village vicinity forests
- ④ Abandoned farmland increasing to attract harmful animals
- ⑤ Local communities worrying about their sustainability

some of above might be the same issues as in Mali

We're here

We're here

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Agrivoltaics has the huge potential to change such suffering regions into more exciting (waku-waku) attractive one!

The Agrivoltaics

- ① sustain agriculture and generate renewable energy on the same land
- ② help small farmers increase and diversify their income
- ③ achieve energy sufficiency and disaster resilience of local communities
- ④ draw youths to locality to find their new lifestyles after covid 19



Waku-waku Solar Sharing Farm full view in winter

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Waku-waku Solar Sharing farm

Overview of our power facility

Began running on Jan 2016
Power generating capacity: 38kw
Annual power generation: 51,000kwh
= 15 households annual consumption
Shading rate in summer: 33%

Agrioltaics=Agri-PV=APV=Solar sharing



Power conditioner

Narrow panels adopted: spec 115w 148cm×51cm
333 panels on 52 pipe scaffolding posts
Site area: 1,200m² (under panel 790m²=0.2ac)
Gross quantity power selling under FIT for 20years
Net annual yield: 5.9%

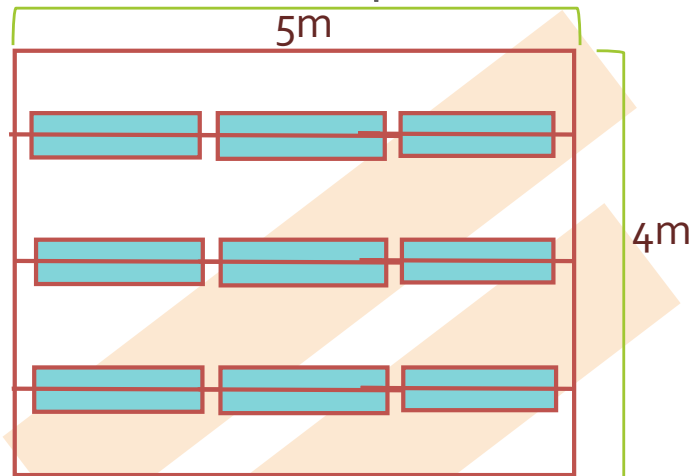
- ※Array not necessarily square shaped
- ※No weed proofing sheet
- ※No fence required

Waku-waku Solar Sharing farm

Foundational Module design

Ground plan view

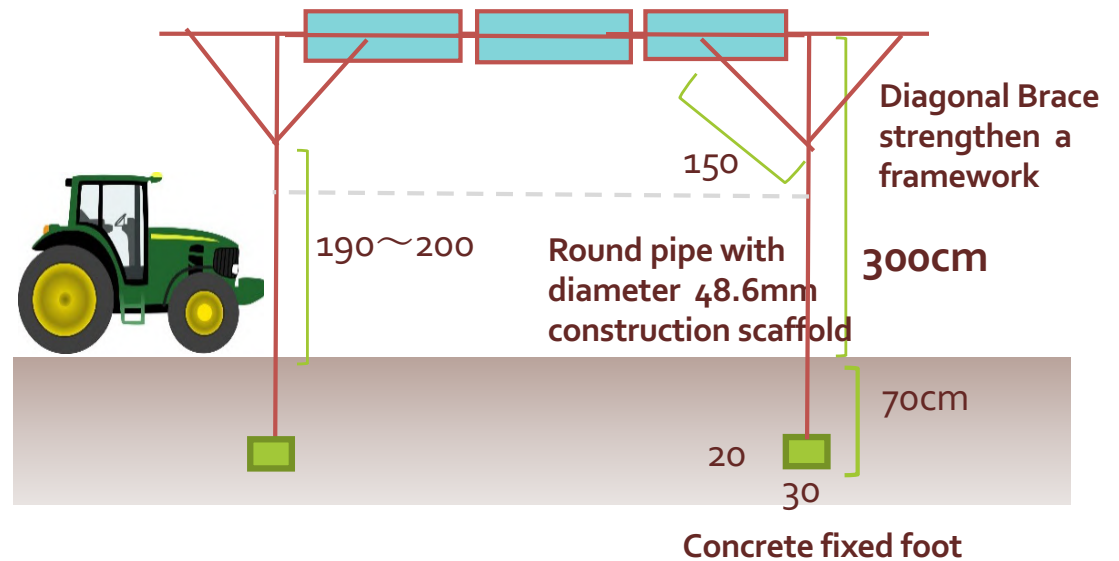
Basically 1 unit consists of 5 square meters with 9 narrow panels inside



Changed a bit to keep 33% of shading rate and to keep two ridge rows in our case

Side view

1feet=30cm



Earth auger digging a hole



DIY can reduce installing costs



Turnable panel device adopted
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Is it a hard job to grow crops under panels ?

Why so many Japanese cites have adopted shade crops to grow ?

From field study in Japan 2018 by Chiba Univ.

rank	Top10 crops	sites
1	Jap. ginger	65
2	Jap. clevera	41
3	Paddy rice	35
4	mushroom	31
5	blueberry	20
6	butterbur	18
7	Tea plant	15
8	Green onion	14
9	Grazing grass	13
10	pumpkin	13

Why not popular crops such as tomato, okra, broccoli and others? Pink shaded vegetables are our growing crops

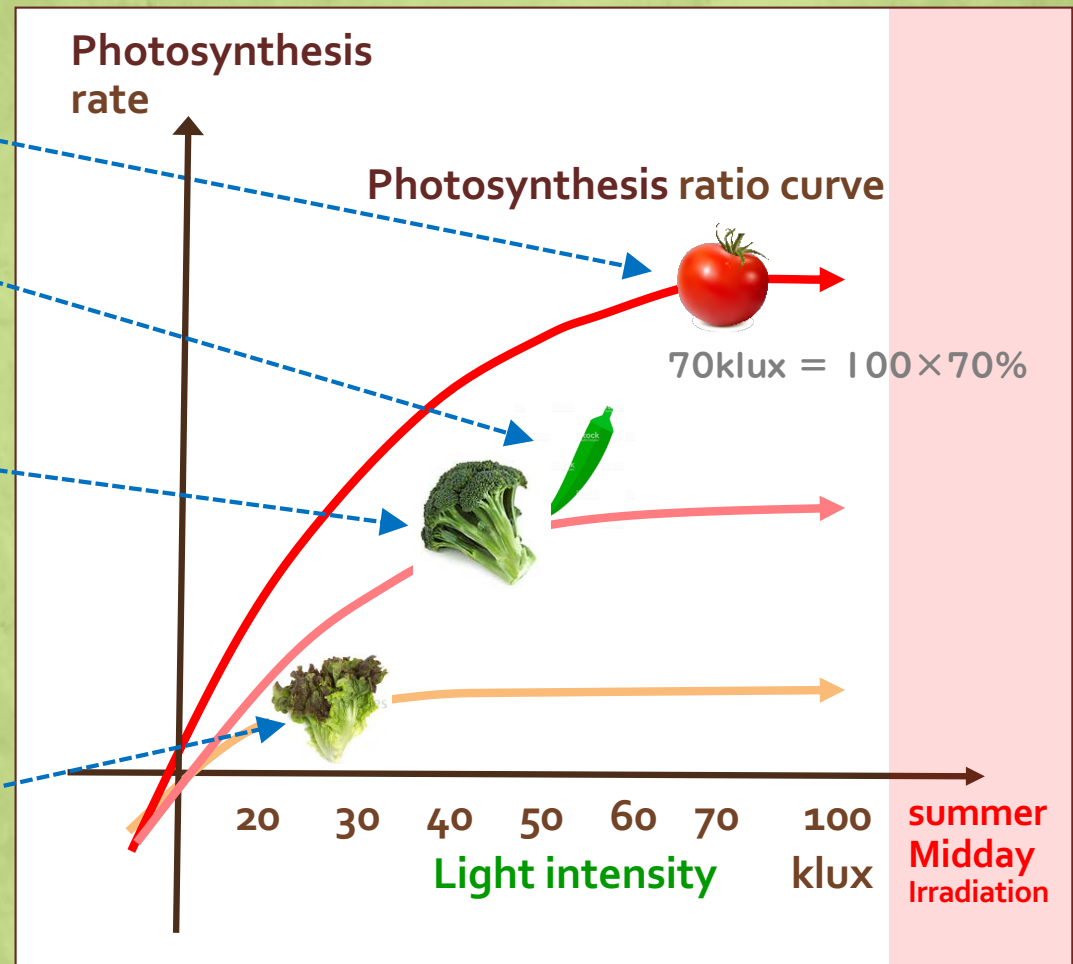
作付け作物	実施事例	作付け作物	実施事例	作付け作物	実施事例	作付け作物	実施事例
ミョウガ	65	白菜	5	舞茸	1	しめじ	1
サカキ	41	シキミ	5	菊豆	1	苔	1
米(水稻)	35	にんにく	5	春菊	1	ハーブ	1
しいたけ	31	ぶどう	4	エンツアイ	1	ナス	1
ブルーベリー	20	栗	4	リーフ	1	スイカ	1
ふき	18	Greensoybean	4	ブラックベリー	1	ジュンベリー	1
茶	15	ハラン	4	スダチ	1	雲南百薬	1
ねぎ	14	ソバ	3	こごみ	1	梅	1
牧草	13	小麦	3	アジサイ	1	ジャバラ	1
かぼちゃ	13	小松菜	3	チンゲンサイ	1	芝桜	1
さつまいも	11	ゆず	3	クリスマスロー	1	万両	1
柿	11	ほうれん草	3	芝	1	オオバコ	1
みかん	9	ニラ	3	球根	1	シブキ	1
大豆	8	ドクダミ	3	クロガネモチ	1	カブ	1
じゃがいも	8	レモン	3	ヤーコン	1	okra	1
里芋	8	キウイ	2	らっきょう	1	はぶ茶	1
アスパラガス	7	いちじく	2	ダイコン	1	清見タンゴール	1
キクラゲ	7	Mini-tomato	2	ヒイラギナンテ	1	桜	1
lettuce	7	馬鈴薯	2	菜花	1	はすいも	1
落花生	7	しょうが	2	三つ葉	1	レンゲ	1
キャベツ	6	ウド	2	ふきのとう	1	飼料作物	1
千両	6	broccoli	2	カリフラワー	1	花シバ	1
わらび	5	山椒	2	ヨモギ	1	桑	1
わさび	5	シソ	2	りんご	1	日向夏	1
Carrot	5	きゅうり	2	ハイゴケ	1	キンカン	1
明日葉	5	デコボン	2	スグリ	1	ナルコユリ	1
玉ねぎ	5	エンドウ	2	花卉	1	ドラセナ	1
大根	5	ごま	2	とうもろこし	1	コーヒー豆	1
たまりゅう	5	レッドクローバ	2	キボウシ	1	ゴーヤ	1
Tomato	5	ハスカップ	1	イチゴ	1	ウコン	1

Theory and practical experience show Crops get enough light irradiation to grow even underneath the 33% shading panel arrays

Each farm crop has its own
Light saturation point .

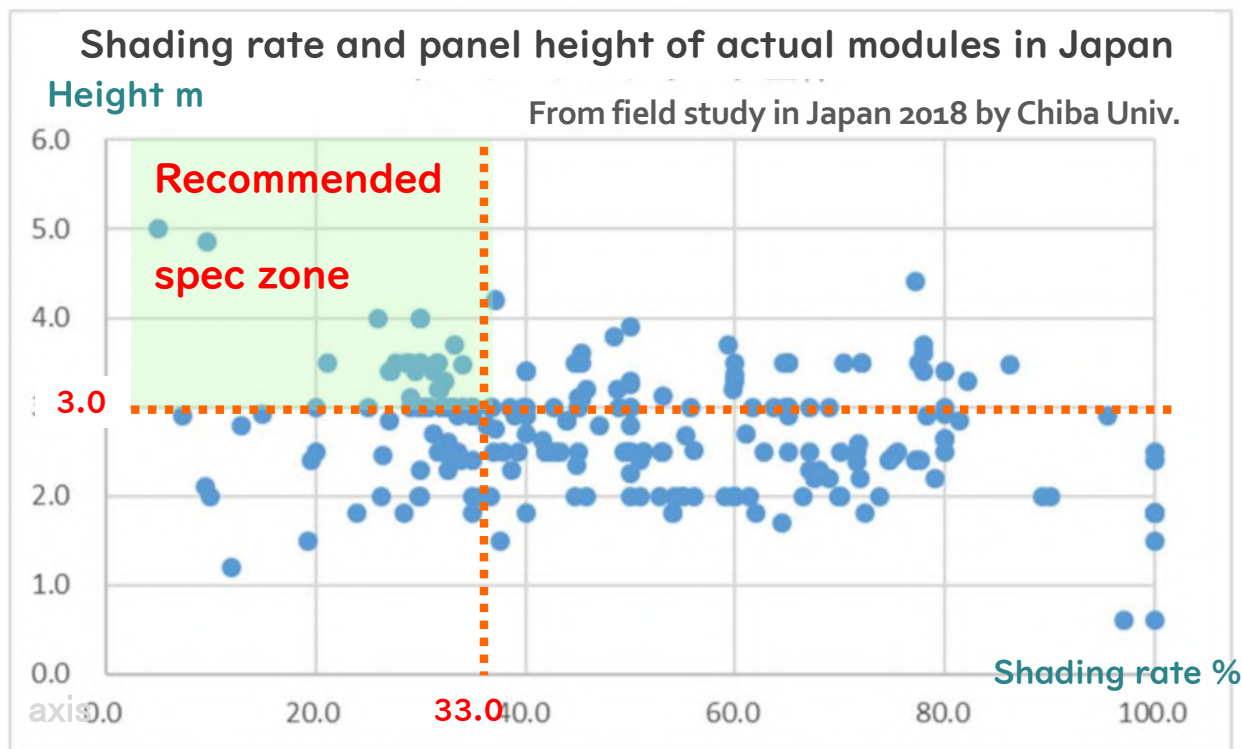
More sun irradiation over the point has
no further effect on the crops growing.

Watermelon	80	klux
Tomato	70	
Potato	60	
Okra	50	
Cucumber	50	
Rice plant	45	
pumpkin	45	
broccoli	45	
Cabbage	40	
Eggplant	40	
Carrot	40	
Green soybean	25	
Onion	25	
Spinach	25	
Lettuce	25	
Strawberry	25	
ginger,tea etc	20	



Now here is the reason why so many shade plants chosen in Japan?

The shading rate and height of panels

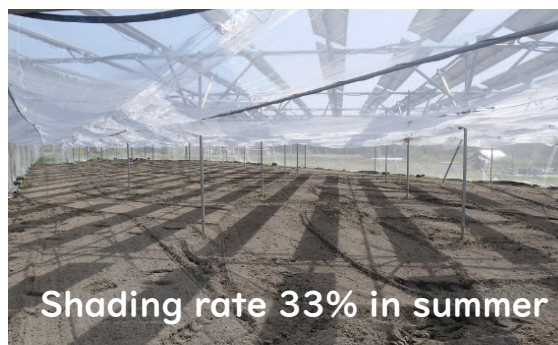
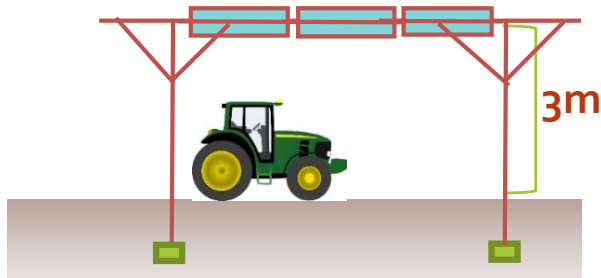


Distributed dots shows many Japanese modules are with high shading rate and low panels height.



It means only shade plants grow under such modules. And crops selection are limited to be shade plants.

To grow various crops flexibly under the panels, You're recommended to keep shading rate at **33% or less** and at the same time panels height should be **3m or greater**.



Waku-waku solar sharing farm 33% shading + 3m height panels

Mini-tomatoes growing



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Waku-waku solar sharing farm 33% shading + 3m height panels

Vegetables grown with chemicals free organic fertilizer
are ready for selling at neighboring SC



Fermenting rice bran and hulls with amino acid enzyme to breed good bacteria



Plowing the organic fertilizer into the soil with slaked lime.

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Waku-waku solar sharing farm 33% shading + 3m height panels

Tomatoes dislike replanting “not same crop same soil”



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Waku-waku solar sharing farm 33% shading + 3m height panels

Okura: popular food in Japan same as in Mali



Waku-waku solar sharing farm 33% shading + 3m height panels
Green soybean: boil and enjoy with beer in summer!



We rotate planting crops with beans avoiding mono-culture
as beans roots microorganisms fix nitrogen from the air

Waku-waku solar sharing farm 33% shading + 3m height panels

Lettuces essential salad ingredients

don't need much irradiations to grow,



Waku-waku solar sharing farm 33% shading + 3m height panels

Carrots disliked by many children though
no stick necessary with our carrots



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Waku-waku solar sharing farm 33% shading + 3m height panels

Broccolies growing in winter





Mounted module frame brings out exciting ideas for farming Tomatoes suspending shelves devised easily



Green house pipes fixed to frame beams along each ridges
Work efficiency increased ten-fold more than before

Hang the tomato stem with thread
by clip sliding as tomato grows

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Mounted module frame brings out exciting ideas for farming

Covered the field with fine mesh nets

to exclude harmful insects/birds and restrain pesticides use



Tomato hanging shelves and wires hold the nets and fixed by clips.
Locust grasshoppers might be kept out to some extent

Excluding useful insects such as bees cause tomato pollination issue
but could be solved by vibrating leaves with handy blower



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Mounted module frame brings out exciting ideas for farming

Tomatoes hydroponic culture under panels
powered by off-grid solar energy solve the replanting issues



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Mounted module frames bring out exciting ideas for farming

Agrivoltaics stimulate creative imaginations

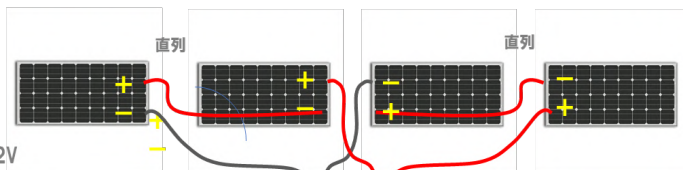
Joyful and profitable farming is coming

Wiring diagram

Hydroponic culture powered by off grid solar power

Solar Panels

120W×4=480W
Nmi max voltage 13.6V
※series+parallel 27.2V



Charge controller

30A 12V 24V



Deep cycle battery

M31MF 12V 100AH × 2
※series 24V



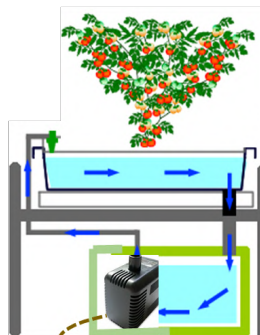
Sine wave inverte

1000W 24V 60Hz
DC input voltage 21-30V
output voltage 110V ±10%



AC100V

Hyponica hydroponic culture



Mini underwater pump
24W 100V



Additional hydroponic installations are ongoing with electric enhancement by wind power appliance. Wind power expected to adjust fluctuations of variable solar energy.

Water supplied slightly automatically as it evaporate from the leaves only.



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Sustainable Development Goals toward 2030 by UN

Agrivoltaics lies at the heart of the SDGs

“ 1 % farmland with APV will afford whole global electric demands” Oregon Univ said



Agrivoltaics

stockholm resilience centre SDGs wedding cake

Small APV for Economy

- circulate money in the regions instead of outflows for energy purchase
- sustain agri-industry and increase RE-jobs
- raise the rural productivity by dual use of land and achieve local economic growth

Small APV for Society

- “produce locally consume locally” revive local society lively and push well-being
- electrify rural community with off-grid
- diversify the disaster risks and be resilient
- draw out environmental concerns of residents opening equitable access to RE

Small APV for Biosphere

- sustain farming and regional biodiversity
- help net zero emission by RE production
- mitigate heat wave and retain soil moisture
- increase agri-yields on dry/unirrigated land

Agrivoltaics bring a happy new era to rural regions and new lifestyles beyond Covid 19



Thank you for your attention