Kingdom of Bhutan where people live in harmony with all the living things—
The possibility to create a nation through Organic Agriculture

0ur heartful respect goes to those who have decided to stop using agrochemicals in the midst of the overwhelming wave of modernization!
We are happy to collaborate with you in order to achieve the noble goal!

Mitsukuni INABA (Civil Institute of Organic Rice Cultivation, Tochigi, Japan)
Koa TASAKA (Asian Rural Institute, Tochigi, Japan)

Three Tasks we have been involved in, in Bhutan;

—Contribute to Bhutan achieving **100%** Food Self sufficiency

—Realization of **SDG**s in the Field of Agriculture

① Rice Cultivation **Without the Use of Agrochemicals**

Establish practical Method to control SHOCHUM & Junkoides

② **Increase of Rice Harvest by 150%**

By the Use of Organic Fertilizer produced from Soy Beans!

③ Improve the self-sufficiency of Basic Foods and the **Creation of New Business Opportunities** through Organic Agriculture using Nutrient Circulation

① Fist Mission:

Rice Cultivation without the use of Agrochemicals

The target → ***SHOCHUM & Junkoides***. Surviving after repeated use of Butachlor which is toxic to fish & aquatic lives.

ブータン王国の農薬使用量の推移

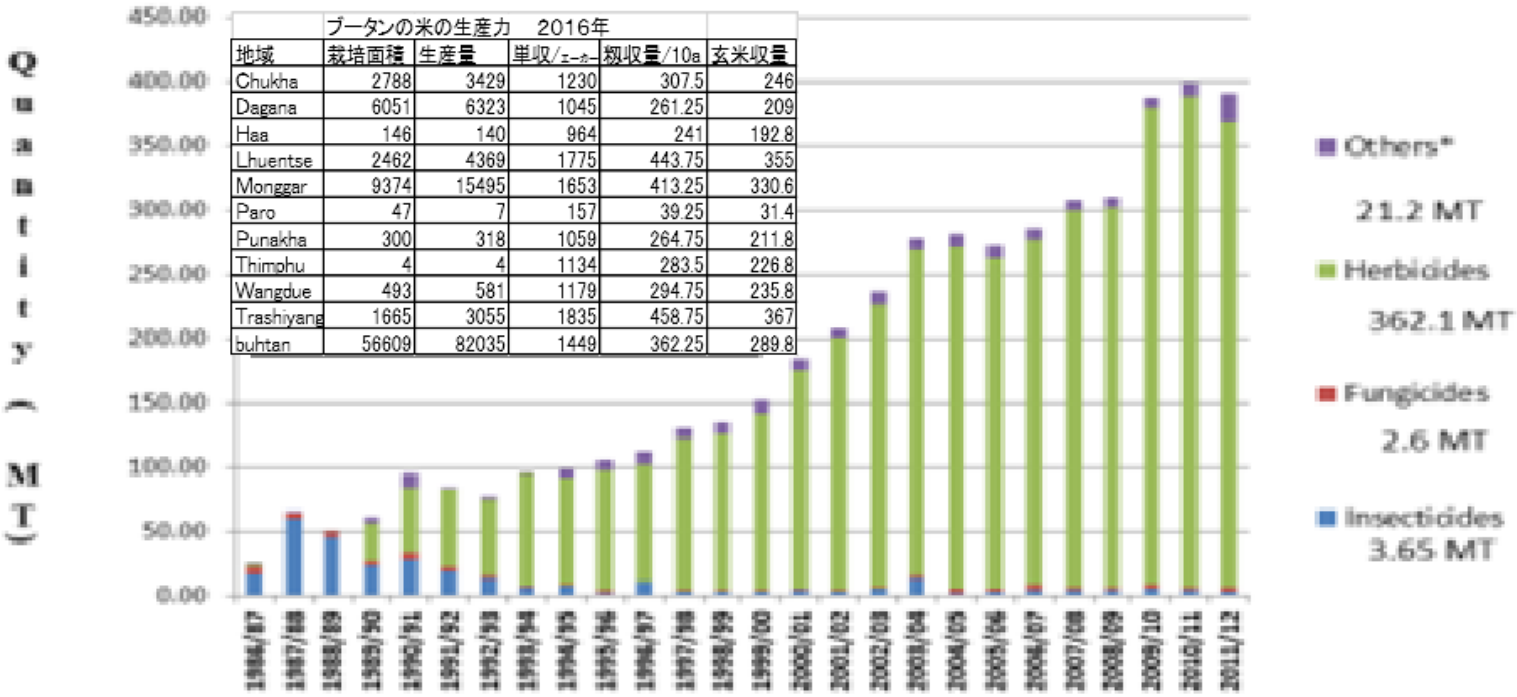
Herbicide (除草剤) fungicide(殺菌剤) insecticide(殺虫剤)

Distribution of Fungicides, Insecticides and Herbicide from 1986-2011, Bhutan.

MT=メトリックT=1000kg

ブータンの米の生産力　2016年

地域	栽培面積	生産量	単収/ｴｰｶｰ	籾収量/10a	玄米収量
Chukha	2788	3429	1230	307.5	246
Dagana	6051	6323	1045	261.25	209
Haa	146	140	964	241	192.8
Lhuentse	2462	4369	1775	443.75	355
Monggar	9374	15495	1653	413.25	330.6
Paro	47	7	157	39.25	31.4
Punakha	300	318	1059	264.75	211.8
Thimphu	4	4	1134	283.5	226.8
Wangdue	493	581	1179	294.75	235.8
Trashiyang	1665	3055	1835	458.75	367
buhtan	56609	82035	1449	362.25	289.8



単位面積当たり362100kg/(米22831ha+トウモロコシ24898ha)=7.6kg

It is said that insecticides were donated from India in 1980s, but the Bhutanese people did not use them for religious reasons. The Government collected the unused insecticides & sent to Switzerland to dispose of them. It seemed easy to achieve 100% organic, but, the use of herbicide increased!

Basics of Weed Control Methods with Biodiversity
Categorize Harmful Weeds in Paddy Field into 4 Types.

①HIE

Echinochloa crus

②KONAGI
(Monochoria vaginalis)

③HOTARUI
(*Scirpus juncoides*)

④Sagitaria trifolia

⑤SHOCHUM

【Annual weeds（Multiply through seeds）】

- **Wetland weeds like HIE*(Echinochloa crusgalli)*** can not germinate & grow without oxygen! They germinate at 14℃.
- **Aquatic weeds like KONAGI（*Monochoria vaginalis*）germinate** from the seeds at the surface of soil within 10mm depth. Germinate at 20℃ earth temperature. High sencitivity to light; Can not germinate & grow without light.

【Perennial weeds（Multiply by bulbs）】

- **Perennial weeds such as *Eleocharus kuroguwai, Sagittaria trifolia* or SHOCHUM produce bulbs in underground soil** at 15～20cm depth in Septt. To Oct. They die out in dry condition. They germinate 15～25days after introducing water.

【Weeds which can co-exist with rice plants】

- **Floating green algae like *Spirogyra arcla or Spirodela polyrhiza* absorb the excessive nitrogen in nitrous acid form, phosphorous, & potassium, thus, purify the water. They also suppress the growth of KONAGI. They stabilize the temperature of water, and finally, become nutrition of rice plants after death.**

Decisive condition for rice cultivation without any use of herbicide is **constant water supply**!

We started our project by digging a pond at the top of the rice terrace!

Seeds of Hotarui (Scirpus Junkoides) tend to float over the surface of water, so, it can be controlled by draining them with water at the time of 3rd puddling. By this practice, most of them disappeared. （Thindreltang, Paro & Bajo）

Shochum germinated after 1st puddling, was put under mud with the 2nd puddling to promote butyric fermentation, and changed to lactic fermentation with the 3rd puddling. Almost no shochum came out after transplantation; PARO,Bajo!

Newly installed method of controlling ***SHOCHUM*** & ***Junkoides.*** Control of *monochoria vaginalis* by biodiversity based on early and winter water filling in continuous rice cropping

KONAGI
M. vaginalis

OMODAKA
S. trifolia

Spread fermented fertilizer or poultry manure
Deep plowing
Guano, spread MG
Marine, fused magnesium phosphate
Harrowing, Leveling (harrow)
Plowing (rotary)
Start irrigation, soil puddling
Research organisms
Remove weed by puddling surface layer
Transplant healthy plants of ๔ to ๕ foliar ages
Rice bran, dust and soy bean pellet
Research organisms

Tubifex, barnyard millet,
Monochoria vaginalis and water net occur

Immediately after harvest
5/20
23
24

Making soil to avoid root rot

Puddle soil with plenty of water to move weed seeds to the surface

Warm water by early filling more than 30 days prior to planting to grow tubifex and green algae so to develop a sticky layer.

2nd Puddling

3rd Puddling

Repeat drive harrow to remove weeds by puddling the deep water layer.

Control weeds and promote rooting to redevelop water net and thick layer.

30 days

Tindreltang Field in the Second Year; Successful Weed Control by Puddling twice and Deep Water management!

Return of Biological diversity

復活した田んぼの生き物たち

6 月にはオタマジャクシ・10 月には猩々トンボの産卵が見られました

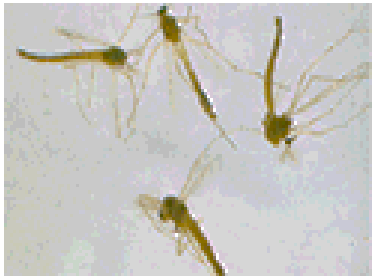
Tadpole（Frog baby) revived within one year practice of Organic Rice Cultivation!

other, and we refrain from cutting all the weeds on the bank, then, the biodiversity is improved & the harmful insects become just one of the insects

By applying rice bran, Chironomids & tubifex increase, which provide feeds for frogs & spiders

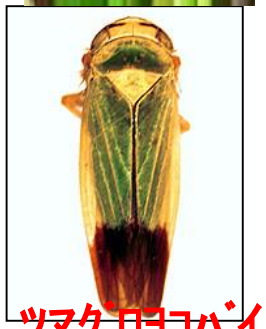
Insect feed

（ただの虫ではない）



Chironomids

Harmful insects



Bee as a parasite of plant hopper

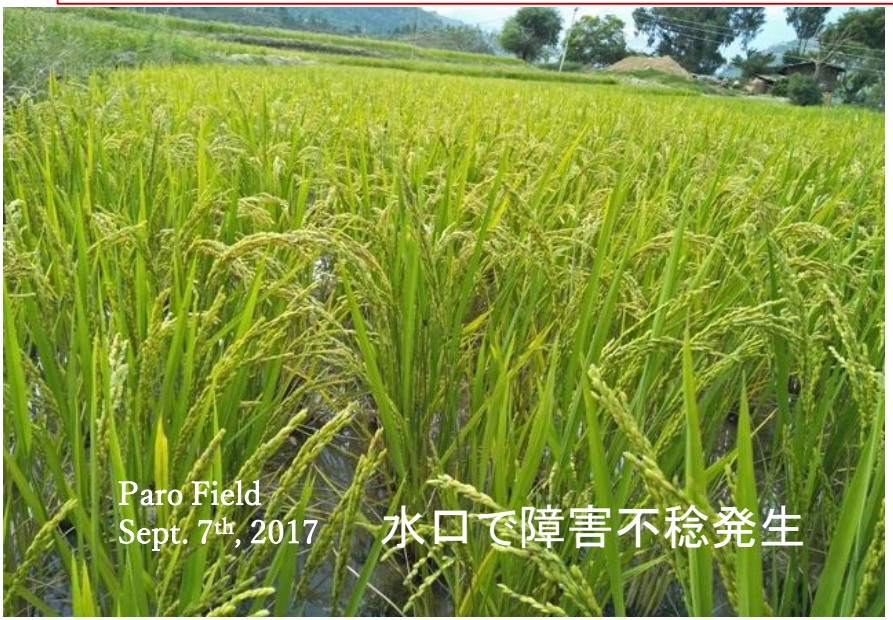
Predators (Beneficial Insects)

ミジンコ

Chironomids larvae

Puddle in April with water, & postpone to drain water from middle of June to July, then, frogs and dragonflies increase! Spiders & bees increase also!

② Second Mission: Increase of Rice Yield by 150%



150% Increase of Rice Yield
360Kg (Average Yield at Present) x 1.5 = 540Kg

Table1 Survey of Component of Yield（ 2017年 variety; SASANISIKI）

Field	Number of Panicle	Number of grains per head	Total grains number	Ripening Ratio	Weight of 1000 grains	B-yield	G-yield
Paro	257	124	31,894	(76.6)	21	513	641
Thimphu	314	97	30,458	78. 3	22	524	655
Japan	256	142	36,263	82. 4	20	597	746

Table2 Survey of Component of Yield （2017年 variety；IR26，64）

Field	variety	Number of Panicle	Number of grains per head	Total grains number	Ripening Ratio	Weight of 1000 grains	B-yield	G-yield
Bajo	IR２８	255.7	177.4	45,358	79.4	16	576	720
	IR64	313.8	121.4	38,090	85.0	16	518	648

It is said that Yield of IR Rice Variety cannot be more than 600 Kg without input of chemical fertilizer. But, we obtained more than 600Kg Yield with the use of 45Kg organic fertilizer made from soy beans which contains 2.25Kg of Nitrogen!

In out second year (2018), we achieved 700Kg yield by overcoming the negative impact of low temperature!

Yield Survey of Organic Rice Cultivation without any use of pesticide (Oct. 11&12, 2018)

Field	Rice Variety	Stock Nr.	Head Nr.	Grain Nr. per head	Total grain Nr.	Ripening Ratio	Weight of 1000 grains	Yield of grain
ParoOrg.Farm	SASANISHIKI	19	254	101.0	25,654	(72.5)	(28.8)	536
Tindreltang Farm	SASANISHIKI	21	334	117.4	39,211	(61.5)	(29.1)	702
	Kanmamap	21	271	87.5	23,712	(78.1)	(31.7)	587

Sasanishiki in Paro encountered water shortage after heading & the ripening ratio went down.
Sasanishiki in Tindreltang showed very high ripening ratio, & there is possibility to give yield higher than average in Japan because
of the big gap of temperature in day and night.

The IR variety was believed to give high yield only with the help of nitrogen fertilizer and pesticide. However, in our trial, only 45Kg of organic fertilizer made from soy beans gave 600Kg yield!

中干しと刈り取り前に拾い草

Comparative test of Organic Fertilizer and Chemical Fertilizer at Pew Agricultural Experiment Station, Myanmar

Big difference in yield and the efficiency of Nitrogen utilization by activating the nitrogen fixing bacteria through the application of organic fertilizer prepared from soy beans and by transplanting single well grown rice plants.

試供品種IR	植付密度（株/㎡）	1株穂数 Ear/stock	1穂粒数	総もみ数（総籾重/㎡）	登熟もみ数/㎡（登熟籾重 g）	登熟歩合（重量比）	千粒重	籾収量 g/㎡
有機成苗 (Organic)	14.0	24.8	134.5	44,654 (905.6g)	34,533 (842.6)	77.3 (93.0)	24.4	842.6
化成成苗 (Chemical)	10.0	24.0	127.9	30,696 (541.3g)	18,143 (444.5)	59.1 (82.1)	24.5	444.5

Average stem Number
Org 30.5 chem 19.2

Organic vs. Chemical Fertilizer

Grain Yield

Organic vs. Chemical Fertilizer

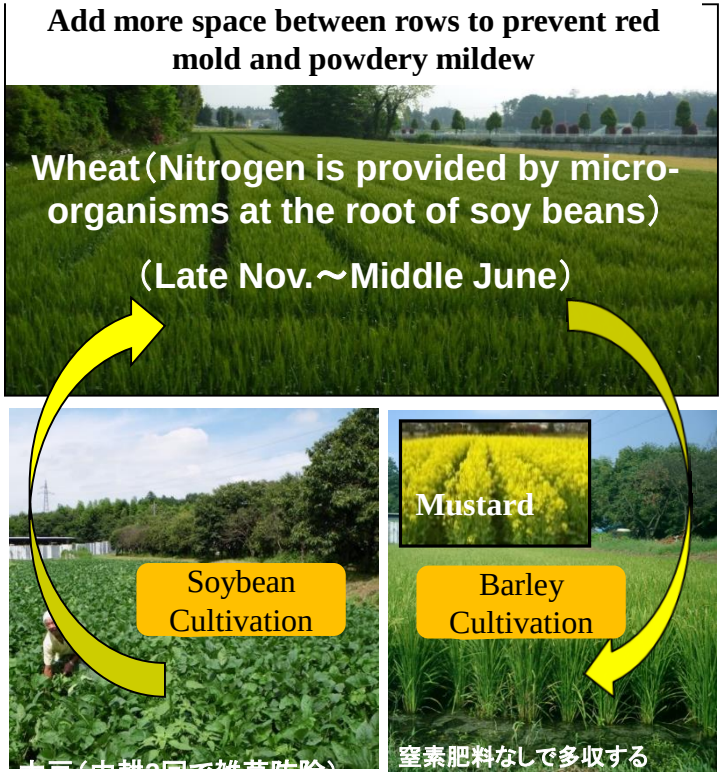
試験区 Examination plot	投入窒素量(kg/10a) Ⓐ Input nitrogen	産出窒素量(kg/10a) Ⓑ Output nitrogen	窒素効率Ⓑ/Ⓐ Nitrogen Fixation
有機成苗 (Organic)	45×0.05＝2.25	842.6×0.8×0.02=13.48	5.99
化学成苗 (Chemical)	75×0.15=11.25	444.5×0.8×0.02= 7.11	0.63

Crop Rotation in organic agriculture with soybean cultivation as the core

By crop rotation with rice-wheat-soybean, rotational organic farming is completed, preventing global warming, achieving a healthy society and diet without exploitation.

① Soybean nitrogen fixing is 24 kg / 10 a (Clover, Hairy Vetch, Astragalus 4kg)
Nitrogen is fixed in the cultivation field and rhizobia remains, so wheat, raper , rice can be cultivated without nitrogen.

② Squeeze oil with harvested soybeans, produce organic fertilizer with defatted soybean (same protein composition as nitrogen-fixing bacteria) and put it in Then, nitrogen-fixing bacteria are activated, and high yield is realized without root rot



Cropping system of recycling type organic agriculture

循環型無農薬・有機農業の作付け体系

年次	作物	1	2	3	4	5	6	7	8	9	10	11	12
1年目	Wheat – rice - barley					▽	収穫			収穫		▽	
2年目	Barley soybean - wheat						収穫	▽			収穫	▽	
3年目	Wheat - rice - Canola					▽	収穫			収穫		▽	

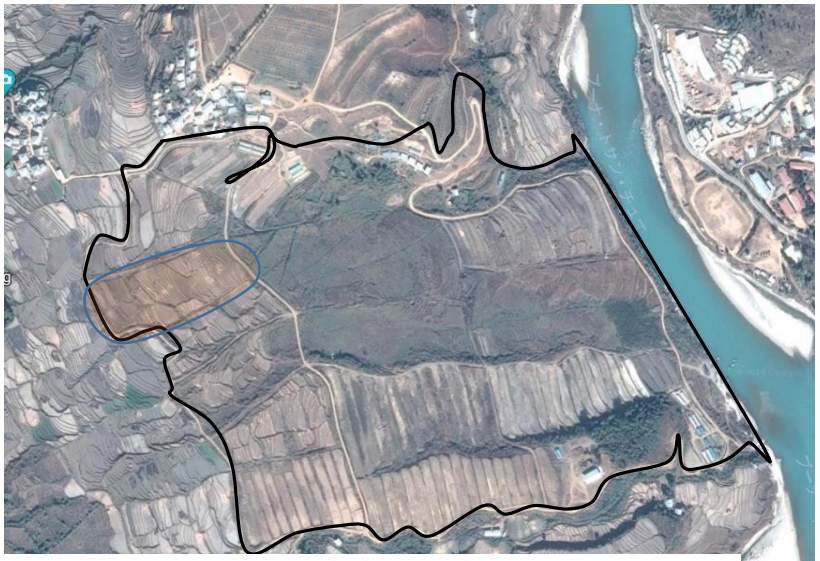
Circulating organic agriculture that discriminates from modern agriculture that has been exploited through chemical fertilizers and Pesticide and forced to destroy the environment

An organic farmer in Paro: A successful rotation of Soy ⇨ Wheat ⇨ Rice
If this method of rotational organic agriculture is practiced, more than 100% sufficiency in basic foods can be achieved.

Canadian Wheat after the harvest of Soy

Rice (No. 11) after harvest of Wheat

The Rotational Organic Agriculture Farm at the Chimipang Royal Project Farm: The production of organic feritilizer through the rotational cultivation of Soy – Rice – Mustard



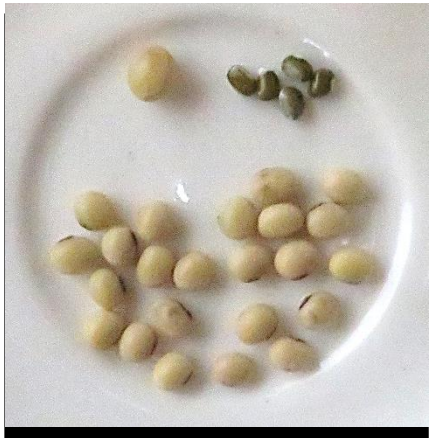
66ha Chimipang Royal Project Farm

Royal Project at Chimipang; Growth of Soy beans

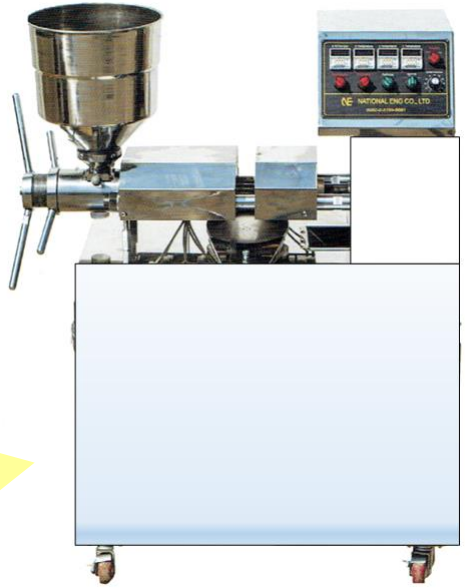
A local variety of Soy beans grew wonderfully!

High quality and high yielding Organic Soybeans at Chimipang

Able to process 200kg/hr



Soybeans can refined using a Korean-made oil squeezing machine that can extract soybean oil, and produce organic fertilizers that will not cause root decay while having the ability to supplying more than six times Nitrogen than that of chemical fertilizers.

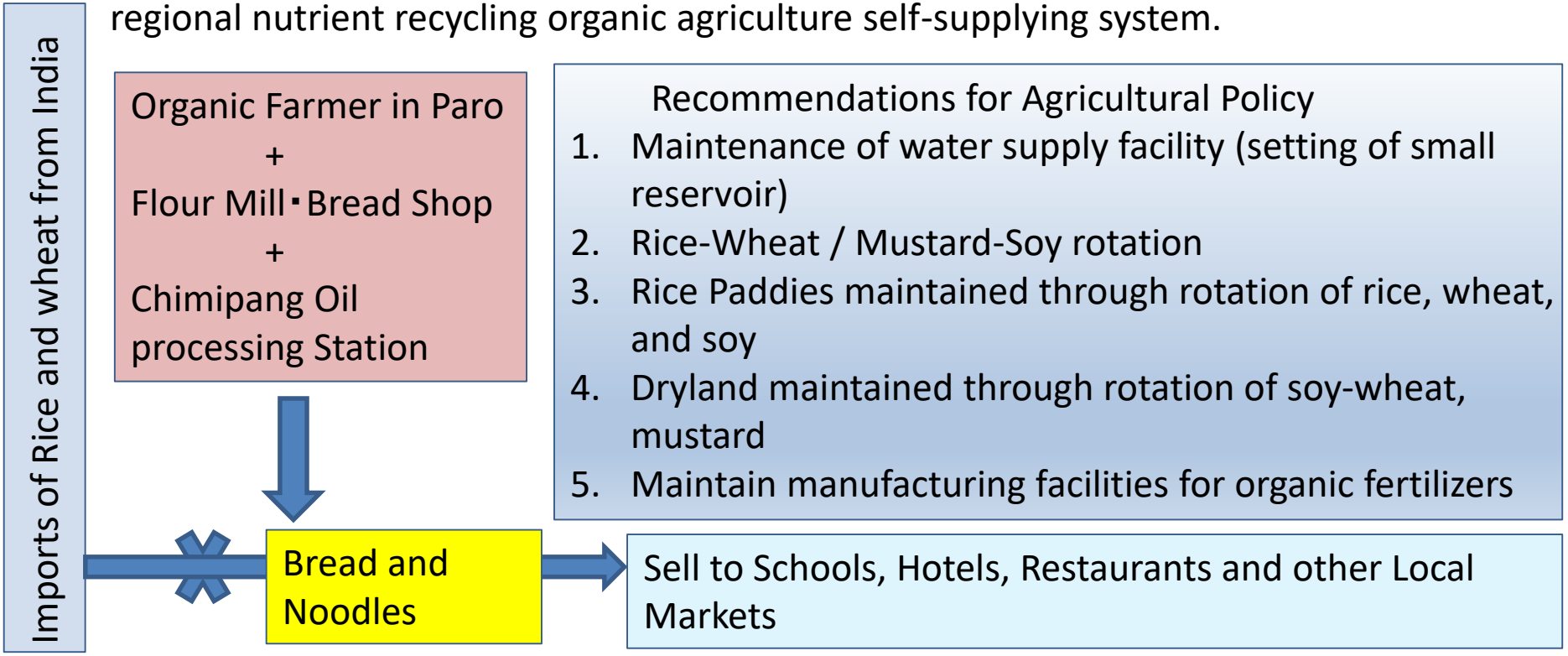


Pic. Oil expeller

③ **Mission 3:** Improve the self-sufficiency of Basic Foods and Create New Business Opportunities –

Steps for 100% food self-sufficiency through organic farming

1. It is difficult to expand the paddy field area, so build a reservoir and increase the harvest 1.5 times without using herbicides or chemical fertilizer while maintaining water conditions.
2. Rotation of wheat, soybean and mustard seed after harvesting rice. Produce processed foods with it such as noodles and bread, and aim at 100% self-sufficiency.
3. Cultivate soybeans and wheat in abandoned fields, produce processed soybean foods and vegetable oil, and produce organic fertilizers from oil gruels, and establish a regional nutrient recycling organic agriculture self-supplying system.



The production of Ramen and Momo with Canadian Wheat

Varieties of Wheat（Sorted by Protein Content）
①Heavy Flour⇒11~14%　Canadian Wheat
②Medium Flour⇒9~11%　窒素を控える
③Light Flour⇒7~9%　For Noodles, Momo

A）Flour Mill ⇒ Ramen, Momo, Bread

B）Flour Mill ⇒ Whole wheat Noodles, dumplings

Canadian soy after soybean cultivation. Seeds planted in November, Harvest Mid-June

When grown without fertilizers, protein content remains ~10% (Medium flour)

If defatted 10 days before flowering, protein levels increase to 12%

A collaboration With Hayate Ramen Noddle Restaurant in Thimphu

The World's first fully organic miso ramen!!!

	Bhutanese Soy	Standard Soy
Protein	37.2%	36.4%
Oil Content	24.6%	21.1%
Water Content	7.1%	9.1%

2019，2，14　ケット科学㈱　測定

Nutrient cycle agriculture as a powerful tool for SDGS

1) Prevent global warming caused by chemical fertilizers, and prevent the destruction of biodiversity caused by herbicides
2) Autonomy through decreasing reliance on chemical pesticides and fertilizers,
3) Empowerment of farmers through self procurement of fertilizers and diversification of income through Processing and selling organic agricultural products.
4) Protecting life and the environment is the most important task that only farmers can do.

SUMMARY

- **Bhutan's initiatives are giving great hope** to Japan and other Asian countries.
- Many people have long talked about organic farming as labour intensive low yielding, that it is impossible to feed the world through organic agriculture. Modern agriculture is said to solve our problems through the heavy usage of chemical fertilizers and pesticides.
- The results, however, increased the gap between the rich and poor, and caused large scale environmental destruction, global warming, and biodiversity loss.
- The nutrient cycling organic farming project initiated in Bhutan had higher yield than that using chemical fertilizers. **This is 21st century agriculture.**
- Importance of agricultural technology to be autonomous of multinational companies that control Japan and other countries in Asia.
- Toward a rich future for family farmers by protecting life and the environment by nutrient cycling organic farming.

Thank you for your kind attention