Vegetables intercropped in orchards at Yusipang Chiwog. (Tshering Gyeltshen)

Vegetable Intercropping in Apple Orchards (Bután)

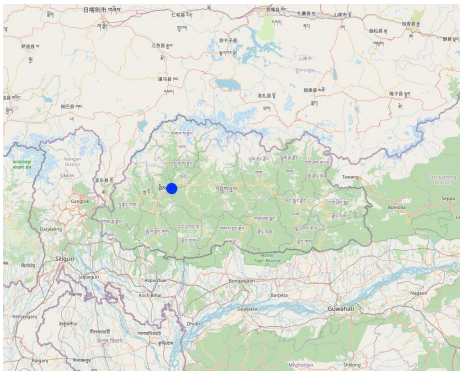
Apple Dhum Ra Nang Tshoe Sey La Sey Tsug Ni (ཨེ་པུལ་ཌུམ་ར་ནང་ཚོད་བསེ་ལྷ་བསེ་བཙུགས་ནི་)

DESCRIPCIÓN

Vegetables are intercropped between fruit-bearing trees in orchards. This maximizes land utilization, increases agrobiodiversity, and optimizes agricultural productivity.

Intercropping of vegetables with fruit-bearing trees in orchards can be an effective system in terms of production and agroecology. It is a sustainable farming technique that optimizes land use, increases agrobiodiversity, diversifies production, and enhances overall yields. Land users in Yusipang grow peas, beans, and cole crops (cabbages, kale, etc.) in their apple orchards.
Intercropping vegetables in orchard land optimizes the use of space, sunlight, water and nutrients. Intercropping also increases biodiversity within the orchard ecosystem. This coexistence of species reduces the vulnerability of the orchard to crop failure and pest infestation: it improves the residence of the overall system.
Trees in the system absorb nutrients from the soil and return them through fallen leaves, thereby improving soil fertility and reducing reliance on external fertilizers. This nutrient recycling improves the overall health of the orchard ecosystem. Intercropping can also help in natural pest management through various mechanisms – including the attraction of beneficial insects - thus reducing the need for chemical pesticides. It also fosters a beneficial microclimate.
To establish intercropping of vegetables in orchards, careful planning and design is required with respect to crop selection, spacing of trees and intercrops, irrigation, and nutrient management. Regular weeding and mulching are required alongside adequate irrigation, integrated pest management, and pruning of fruit trees to prevent competition for light and space.
Intercropping of vegetables in orchards thus offers multiple benefits to farmers and the overall agricultural system, including increased farm productivity. It increases climate resilience and improves the health of the agroecosystem. However, it is important to be aware of potential drawbacks. These include competition between crops for resources - and labour. Sound management practices can overcome these challenges and maximize the effectiveness of intercropping.

LUGAR



Lugar: Yusipang, Chang Gewog, Thimphu Dzongkhag, Thimphu, Bután

No. de sitios de Tecnología analizados: un solo sitio

Georreferencia de sitios seleccionados
- 89.71344, 27.46436

Difusión de la Tecnología: distribuida parejamente sobre un área (0.4 km²)

¿En un área de protección permanente?: No

Fecha de la implementación: 10-50 años atrás

Tipo de introducción
- [ ] mediante la innovación de usuarios de tierras
- [x] como parte de un sistema tradicional (> 50 años)
- [ ] durante experimentos/ investigación
- [ ] mediante proyectos/ intervenciones externas

Far view of the northern part of the orchard. Here the land user has planted many vegetables such as cauliflower, beetroot, chilli, and maize within the orchard. (Tshering Gyeltshen)

CLASIFICACIÓN DE LA TECNOLOGÍA

Propósito principal

- [ ] mejorar la producción
- [x] reducir, prevenir, restaurar la degradación del suelo
- [x] conservar el ecosistema
- [ ] proteger una cuenca hidrográfica/ áreas corriente abajo – en combinación con otras Tecnologías
- [x] preservar/ mejorar biodiversidad
- [x] reducir el riesgo de desastres naturales
- [ ] adaptarse al cambio climático/ extremos climáticos y sus impactos
- [ ] mitigar cambio climático y sus impactos
- [x] crear impacto económico benéfico
- [ ] crear impacto social benéfico

Uso de tierra

Mezcla de tipos de uso de tierras dentro de la misma unidad de tierras: Sí - Agroforestería

Tierras cultivadas

- Cosecha anual: vegetales - otros, vegetales - vegetales de raíz (zanahorias, cebollas, remolachas, otros) , Cole crops, chili, beans, peas
- Cosecha de árboles y arbustos

Número de temporadas de cultivo por año: 1
¿Se practica el intercultivo? Sí
¿Se practica la rotación de cultivos? Sí

Provisión de agua

- [ ] de secano
- [x] mixta de secano – irrigada
- [ ] totalmente irrigada

Propósito relacionado a la degradación de las tierras

- [x] prevenir la degradación del suelo
- [x] reducir la degradación del suelo
- [ ] restaurar/ rehabilitar tierra severamente degradada
- [ ] adaptarse a la degradación del suelo
- [ ] no aplica

La degradación considerada

erosión de suelos por agua - Wt: pérdida de capa arable/ erosión de la superficie , Wg: erosión en cárcavas

erosión de suelos por viento - Et: pérdida de capa arable

deterioro físico del suelo - Pc: compactación , Ps: hundimiento de suelos orgánicos, asentamiento del suelo

degradación biológica - Bc: reducción de la cobertura vegetal del suelo

Grupo MST

- agroforestería
- sistemas de rotación (rotación de cosecha, cosecha rotatoria con descanso, agricultura migratoria)
- cobertura de suelo/ vegetal mejorada

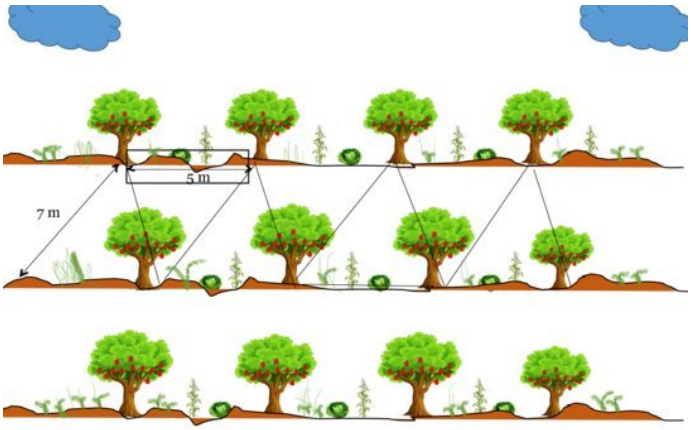
Medidas MST

medidas agronómicas - A1: vegetación/ cubierta del suelo

DIBUJO TÉCNICO

Especificaciones técnicas

None



Author: Designed by Tshering Gyeltshen

ESTABLECIMIENTO/ MANTENIMIENTO: ACTIVIDADES, INSUMOS Y COSTOS

Cálculo de insumos y costos

- Los costos se calculan: por área de Tecnología (unidad de tamaño y área: **1 acre**; factor de conversión a una hectárea: **1 ha = 1 acre**)
- Moneda usada para calcular costos: **BTN**
- Tasa de cambio (a USD): 1 USD = 81.0 BTN
- Costo promedio por día del sueldo de la mano de obra contratada: Nu. 800

Factores más determinantes que afectan los costos

n.d.

Actividades de establecimiento

1. Assess the orchard: Evaluate the orchard's existing conditions, including soil fertility, drainage, sunlight availability, and pest and disease history. This assessment will help determine the feasibility and suitability of intercropping vegetables in the orchard. (Momento/ frequencia: Anytime)
2. Select compatible vegetable crops: Choose vegetable crops that are compatible with the existing fruit trees in terms of their growth requirements, sunlight tolerance, water needs, and harvesting periods. Consider crops that are less competitive and can thrive in the orchard's microclimate. (Momento/ frequencia: Year-round)
3. Plan the intercropping layout: Develop a planting design that optimises space utilisation and resource distribution. Consider factors such as crop spacing, row orientation, and the arrangement of vegetable crops within the orchard. Ensure that the intercropped vegetables are positioned to minimise shading and competition with the fruit trees. (Momento/ frequencia: Anytime)
4. Prepare the soil: Prior to planting, prepare the soil by clearing any existing vegetation and weeds. Conduct soil testing to assess nutrient levels and pH, and amend the soil if necessary to create optimal growing conditions for both the vegetables and fruit trees. (Momento/ frequencia: Spring)
5. Implement irrigation systems: Install or adapt irrigation systems to accommodate the intercropped vegetables' water requirements. Consider the water needs of both the vegetables and fruit trees when determining irrigation frequency and duration. (Momento/ frequencia: Anytime)
6. Manage nutrients: Determine the nutrient requirements of the intercropped vegetables and fruit trees. Based on soil test results, develop a fertilization plan that addresses the nutritional needs of both crops. Apply organic or synthetic fertilizers as appropriate, considering the specific nutrient requirements of each crop. (Momento/ frequencia: Anytime)
7. Implement pest and disease management strategies: Develop an integrated pest management (IPM) plan to control pests and diseases effectively. Monitor the orchard regularly for signs of pests or diseases and take appropriate preventive or corrective actions, such as using natural predators, applying organic pesticides, or practising cultural methods like crop rotation. (Momento/ frequencia: After plantation)
8. Weed management: Employ weed control measures to minimise competition between the vegetables and fruit trees. This can include mulching the soil around plants, practising regular manual weeding, or using targeted herbicides that are safe for both crops. (Momento/ frequencia: After plantation)
9. Monitor and adjust: Continuously monitor the growth and performance of both the vegetables and fruit trees throughout the growing season. Make necessary adjustments to irrigation, fertilisation, pest control, and other management practices based on observations and the specific needs of each crop. (Momento/ frequencia: Year-round)

Costos totales de establecimiento (estimación)
23000,0

Actividades de mantenimiento
n.a.

Total de los costos de mantenimiento (estiamción)
6000,0

ENTORNO NATURAL

Promedio anual de lluvia
- [ ] < 250 mm
- [ ] 251-500 mm
- [x] 501-750 mm
- [x] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Zona agroclimática
- [ ] húmeda
- [ ] Sub-húmeda
- [ ] semi-árida
- [ ] árida

Especificaciones sobre el clima
The average rainfall ranges from 650-850 mm.
Nombre de la estación meteorológica: The rain estimate has been derived based on the agro-ecological zone (AEZ) the area falls under. Bhutan is divided into AEZs (source: https://www.fao.org/3/ad103e/AD103E02.htm).
The area falls under Cool Temperate Zone. Bhutan has six AEZs. The wet sub-tropical zone is from 150 to 600 m, followed by the humid sub-tropical zone from 600 to 1,200 m. The dry sub-tropical zone starts at 1,200 m and extends to 1,800 m, followed by the warm temperate zone, which reaches 2,600 m. The cool temperate zone lies between 2,600 and 3,600 m and, finally, the alpine zone between 3,600 m and 4,600 m.

Pendiente
- [ ] plana (0-2 %)
- [ ] ligera (3-5%)
- [x] moderada (6-10%)
- [ ] ondulada (11-15%)
- [ ] accidentada (16-30%)
- [ ] empinada (31-60%)
- [ ] muy empinada (>60%)

Formaciones telúricas
- [ ] meseta/ planicies
- [ ] cordilleras
- [ ] laderas montañosas
- [x] laderas de cerro
- [ ] pies de monte
- [ ] fondo del valle

Altura
- [ ] 0-100 m s.n.m.
- [ ] 101-500 m s.n.m.
- [ ] 501-1,000 m s.n.m
- [ ] 1,001-1,500 m s.n.m
- [ ] 1,501-2,000 m s.n.m
- [ ] 2,001-2,500 m s.n.m
- [x] 2,501-3,000 m s.n.m
- [ ] 3,001-4,000 m s.n.m
- [ ] > 4,000 m s.n.m

La Tecnología se aplica en
- [ ] situaciones convexas
- [ ] situaciones cóncavas
- [x] no relevante

Profundidad promedio del suelo
- [ ] muy superficial (0-20 cm)
- [ ] superficial (21-50 cm)
- [x] moderadamente profunda (51-80 cm)
- [ ] profunda (81-120 cm)
- [ ] muy profunda (>120 cm)

Textura del suelo (capa arable)
- [x] áspera/ ligera (arenosa)
- [ ] mediana (limosa)
- [x] fina/ pesada (arcilla)

Textura del suelo (> 20 cm debajo de la superficie)
- [x] áspera/ ligera (arenosa)
- [ ] mediana (limosa)
- [x] fina/ pesada (arcilla)

Materia orgánica de capa arable
- [x] elevada (>3%)
- [ ] media (1-3%)
- [ ] baja (<1%)

Agua subterránea
- [ ] en superficie
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Disponibilidad de aguas superficiales
- [ ] excesiva
- [x] bueno
- [ ] mediana
- [ ] pobre/ ninguna

Calidad de agua (sin tratar)
- [x] agua potable de buena calidad
- [ ] agua potable de mala calidad (requiere tratamiento)
- [ ] solo para uso agrícola (irrigación)
- [ ] inutilizable

La calidad de agua se refiere a:
agua superficial

¿La salinidad del agua es un problema?
- [ ] Sí
- [x] No

Incidencia de inundaciones
- [ ] Sí
- [x] No

Diversidad de especies
- [x] elevada
- [ ] mediana
- [ ] baja

Diversidad de hábitats
- [ ] elevada
- [x] mediana
- [ ] baja

LAS CARACTERÍSTICAS DE LOS USUARIOS DE LA TIERRA QUE APLICAN LA TECNOLOGÍA

Orientación del mercado
- [ ] subsistencia (autoprovisionamiento)
- [x] mixta (subsistencia/ comercial)
- [ ] comercial/ mercado

Ingresos no agrarios
- [x] menos del 10% de todos los ingresos
- [ ] 10-50% de todo el ingreso
- [ ] > 50% de todo el ingreso

Nivel relativo de riqueza
- [ ] muy pobre
- [ ] pobre
- [x] promedio
- [ ] rico
- [ ] muy rico

Nivel de mecanización
- [ ] trabajo manual
- [ ] tracción animal
- [x] mecanizado/motorizado

Sedentario o nómada
- [x] Sedentario
- [ ] Semi-nómada
- [ ] Nómada

Individuos o grupos
- [x] individual/ doméstico
- [ ] grupos/ comunal
- [ ] cooperativa
- [ ] empleado (compañía, gobierno)

Género
- [x] mujeres
- [ ] hombres

Edad
- [ ] niños
- [ ] jóvenes
- [x] personas de mediana edad
- [ ] ancianos

Área usada por hogar
- [x] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Escala
- [x] pequeña escala
- [ ] escala mediana
- [ ] gran escala

Tenencia de tierra
- [ ] estado
- [ ] compañía
- [ ] comunitaria/ aldea
- [ ] grupal
- [x] individual, sin título
- [ ] individual, con título

Derechos de uso de tierra
- [ ] acceso abierto (no organizado)
- [ ] comunitarios (organizado)
- [ ] arrendamiento
- [x] individual

Derechos de uso de agua
- [ ] acceso abierto (no organizado)
- [x] comunitarios (organizado)
- [ ] arrendamiento
- [ ] individual

Acceso a servicios e infraestructura

salud	pobre	bueno
educación	pobre	bueno
asistencia técnica	pobre	bueno
empleo (ej. fuera de la granja)	pobre	bueno
mercados	pobre	bueno
energía	pobre	bueno
caminos y transporte	pobre	bueno
agua potable y saneamiento	pobre	bueno
servicios financieros	pobre	bueno

IMPACTO

Impactos socioeconómicos

Producción de cultivo	disminuyó	incrementó	Crop production has increased due to intercropping.
riesgo de fracaso de producción	incrementó	disminuyó	The risk of production failure is decreased due to crop diversity. Even if one commodity fails, other surviving commodities make up for the loss.
diversidad de producto	disminuyó	incrementó	Crop diversity has increased.
área de producción (nuevas tierras bajo cultivo/ en uso)	disminuyó	incrementó	Intercropping has led to maximum utilization of the orchard area.
manejo de tierras	obstaculizado	simplificado	Land management has improved with better land utilization through intercropping.
demanda de agua para irrigar	incrementó	disminuyó	Increase in water requirement due to full, efficient utilization of the land and more number of diverse plants growing on the land.
ingreso agrario	disminuyó	incrementó	Farm income has increased due to diverse sources of income.
diversidad de fuentes de ingreso	disminuyó	incrementó	The land user has two different sources of income, fruits and vegetables.
carga de trabajo	incrementó	disminuyó	Increased workload due to many different crops covering the land.

Impactos socioculturales

seguridad alimentaria/ autosuficiencia	disminuyó	mejoró	Farm income has increased due to diverse sources of income from intercropping.
MST/ conocimiento de la degradación del suelo	disminuyó	mejoró	Intercropping reduces nutrient depletion associated with monoculture.

Impactos ecológicos

cubierta del suelo	disminuyó	mejoró	Soil cover has increased due to intercropping of different vegetables between apple trees.
pérdida de suelo	incrementó	disminuyó	Soil erosion has decreased due to increased soil cover.

ciclo/ recarga de nutrientes

disminuyó ✓ incrementó

Nutrient cycling has improved. Fruit trees absorb nutrients from the soil and release them back into the soil through decomposed fallen leaves, branches, or other parts.

cubierta vegetal

disminuyó ✓ incrementó

Vegetation cover has increased due to the growing of a mix of vegetables between the trees in the orchard.

diversidad vegetal

disminuyó ✓ incrementó

Different vegetables are intercropped and rotated in the orchard.

diversidad de hábitats

disminuyó ✓ incrementó

Different crops provide habitats to a variety of living organisms.

micro-clima

empeoró ✓ mejoró

Micro-climate has increased as fruit trees provide shade and regulate temperature, act as windbreaks, and the soil cover through various vegetables helps retain moisture in the soil by preventing erosion.

Impactos fuera del sitio

impacto de gases de invernadero

incrementó ✓ disminuyó

Intercropping enhances carbon sequestration in the soil.

ANÁLISIS COSTO-BENEFICIO

Beneficios comparados con los costos de establecimiento

Ingresos a corto plazo: muy negativo ✓ muy positivo

Ingresos a largo plazo: muy negativo ✓ muy positivo

Beneficios comparados con costos de mantenimiento

Ingresos a corto plazo: muy negativo ✓ muy positivo

Ingresos a largo plazo: muy negativo ✓ muy positivo

CAMBIO CLIMÁTICO

Cambio climático gradual

temperatura anual incrementó: nada bien ✓ muy bien

temperatura estacional incrementó: nada bien ✓ muy bien

Estación: verano

lluvia anual disminuyó: nada bien ✓ muy bien

Extremos (desastres) relacionados al clima

tormenta de nieve local: nada bien ✓ muy bien

ola de frío: nada bien ✓ muy bien

insectos/ infestación de gusanos: nada bien ✓ muy bien

ADOPCIÓN Y ADAPTACIÓN

Porcentaje de usuarios de la tierra que adoptaron la Tecnología

- [ ] casos individuales / experimentales
- [x] 1-10%
- [ ] 11-50%
- [ ] > 50%

De todos quienes adoptaron la Tecnología, ¿cuántos lo hicieron sin recibir incentivos/ pagos materiales?

- [ ] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [x] 91-100%

¿La tecnología fue modificada recientemente para adaptarse a las condiciones cambiantes?

- [ ] Sí
- [x] No

¿A qué condiciones cambiantes?

- [ ] cambios climáticos / extremos
- [ ] mercados cambiantes
- [ ] disponibilidad de mano de obra (ej. debido a migración)

CONCLUSIONES Y LECCIONES APRENDIDAS

Fortalezas: perspectiva del usuario de tierras

- 1. Increased land productivity: Intercropping vegetables in orchards allows for more efficient use of land by utilizing the space between fruit trees. This increases overall productivity and maximizes the yield from the same area of land.
- 2. Diversified income streams: By intercropping vegetables, orchard owners can generate additional income from the sale of

Debilidades/ desventajas/ riesgos: perspectiva del usuario de tierrascómo sobreponerse

- Competition for resources: Intercropped vegetables and fruit trees compete for essential resources such as water, nutrients, sunlight, and space. This competition can result in reduced growth and yield for both crops. Supply adequate nutrients.

different crops. This helps to diversify their revenue streams and reduce dependence on a single crop, thereby minimizing financial risks.
- 3. Improved pest and disease management: Certain vegetable crops can act as natural pest repellents or trap crops, effectively reducing the population of pests that target fruit trees. By intercropping, orchard owners can create a more balanced ecosystem, leading to better pest and disease management without relying heavily on chemical interventions.

Fortalezas: punto de vista del compilador o de otra persona recurso clave

- 1. Enhanced soil fertility and nutrient cycling: Intercropping systems often involve the planting of leguminous vegetables, such as peas or beans, which are capable of fixing atmospheric nitrogen and improving soil fertility. These vegetables can replenish nitrogen levels in the soil, benefiting the overall health and growth of both the fruit trees and the intercropped vegetables.
- 2. Weed suppression: Intercropping vegetables can help suppress weed growth in orchards. The dense foliage of intercropped vegetables can shade out and outcompete weeds, reducing the need for manual weeding or herbicide application. This results in reduced labour and cost associated with weed control.
- 3. Microclimate regulation: Intercropping can modify the microclimate within the orchard. The intercrop plants provide shade and windbreak, which can help regulate temperature, humidity, and air movement. These microclimate modifications can protect fruit trees from extreme weather conditions and create more favorable growing conditions, promoting overall orchard health.
- Increased management complexity: Intercropping adds complexity to the management of the orchard. Different crops may have different requirements in terms of irrigation, fertilization, pest control, and harvesting, requiring additional attention and labour. Proper planning and management taking into consideration differing requirements.

Debilidades/ desventajas/ riesgos: punto de vista del compilador o de otra persona recurso clavecómo sobreponerse

- Difficulty in weed control: Intercropping can make weed control more challenging. Different crops may have different susceptibilities to weeds, and managing weeds without harming the intercropped vegetables or fruit trees can be demanding. Weed management and different control measures should be taken.
- Reduced crop specialisation: Intercropping can limit the space available for each crop, leading to reduced specialisation. This may result in lower yields compared to cultivating a single crop in a dedicated area with optimised growing conditions. Must keep proper/required spaces between each of the plants.
- Harvesting difficulties: Harvesting intercropped vegetables in an orchard can be more time-consuming and labour-intensive compared to harvesting a single crop. The presence of fruit trees and the arrangement of different crops may hinder access and make harvesting more challenging. Mechanized harvesting may reduce time taken for harvest.

REFERENCIAS

Compilador
Tshering Yangzom

Editors
Kuenzang Nima

Revisado por
William Critchley
Rima Mekdaschi Studer
Joana Eichenberger

Fecha de la implementación: 10 de julio de 2023

Últimas actualización: 30 de mayo de 2024

Personas de referencia
Rai Sharman - usuario de la tierra

Descripción completa en la base de datos de WOCAT
https://qcat.wocat.net/es/wocat/technologies/view/technologies_6844/

Datos MST vinculados
n.d.

La documentación fue facilitada por

Institución
- National Soil Services Center, Department of Agric (National Soil Services Center, Department of Agric) - Bután

Proyecto
- Strengthening national-level institutional and professional capacities of country Parties towards enhanced UNCCD monitoring and reporting – GEF 7 EA Umbrella II (GEF 7 UNCCD Enabling Activities_Umbrella II)

Referencias claves

- Mishra, U. & Wani, N. A. (2022). An integrated circular economic model with controllable carbon emission and deterioration from an apple orchard.: Google Scholar
- Hashemi, A. & Karamidehkordi, E. (2010). FARMERS'KNOWLEDGE OF INTEGRATED PEST MANAGEMENT: A CASE STUDY IN THE ZANJAN PROVINCE IN IRAN.: Free website
- Kumar, L. & Chhogyel, N. (2018). Climate change and potential impacts on agriculture in Bhutan: a discussion of pertinent issues.: Free source

Vínculos a la información relevante disponible en línea

- An integrated circular economic model with controllable carbon emission and deterioration from an apple orchard: https://doi.org/10.1016/j.jclepro.2022.133962
- FARMERS'KNOWLEDGE OF INTEGRATED PEST MANAGEMENT: A CASE STUDY IN THE ZANJAN PROVINCE IN IRAN.: https://hal.science/hal-00510402
- Climate change and potential impacts on agriculture in Bhutan: a discussion of pertinent issues: https://agricultureandfoodsecurity.biomedcentral.com/articles/10.1186/s40066-018-0229-6