МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

ЦЕНТРАЛЬНОУКРАЇНСЬКИЙ НАЦІОНАЛЬНИЙ
ТЕХНІЧНИЙ УНІВЕРСИТЕТ

КАФЕДРА ІНОЗЕМНИХ МОВ

Англійська мова

для студентів технічних спеціальностей:

«Процеси, машини та обладнання агропромислового виробництва»

(електронне видання)

Затверджено на засіданні кафедри:

Протокол №1 від «31» серпня 2020 р.

Кропивницький
2020

Англійська мова для студентів технічних спеціальностей: «Процеси, машини та обладнання агропромислового виробництва». Методична розробка (електронне видання). /Укладач: Г.В. Штомпель, викладач кафедри іноземних мов ЦНТУ. – Кропивницький, 2020, -с.45, 51707 др.зн. 1,6 ум. др. арк.

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Навчальний посібник призначений для вивчення англійської мови як мови професійного спрямування для студенів спеціальностей «Процеси, машини та обладнання агропромислового виробництва». Для ознайомлення та обговорення пропонуються тексти та завдання різного рівня складності.

До кожного тексту пропонуються запитання та завдання, які сприяють кращому розумінню обговорюваного матеріалу; вправи на переклад з української мови на англійську, що в комплексі з читанням, перекладом та обговоренням текстів сприяє розвитку комунікативної мовленнєвої компетенції студентів та забезпечує діяльнісно-орієнтований підхід до вивчення іноземної мови.

Рекомендований для студентів денної, очної, заочної, дистанційної форм навчання, для вступаючих до магістратури або аспірантури.

Unit 1

Exercise I

a) Прочитайте міжнародні слова і перекладіть їх:

industrial	locomotive	generation
revolution	stationary	combine
machine	standard	mobile
method	farmer	
farming	tractor	
machinery	diesel	

b) Прочитайте наступні слова і запам'ятайте їх. Перекладіть приклади їх використання *(score 12)*

development	розвиток
complicated machines	складні механізми
the development of more complicated machines	
farming methods	сільськогосподарські методики
leap	скребок
farming methods took a great leap forward	
harvesting	збір врожаю
grain	зерно
sharp blade	коса
harvesting grain by hand with a sharp blade	
wheeled machines	колісні механізми (машини)

swath	смуга скошеної трави
wheeled machines cut a continuous swath	
threshing	молотьба
beating	биття
stick	палиця
instead of threshing the grain by beating it with sticks	
seed(s)	
stalk(s)	
the seeds from the heads and stalks	
steam power	сімена
agricultural machinery	стебла
power for agricultural machinery	
domesticated animals	домашні тварини
invention	винахід
portable engine	портативний двигун
with the invention of steam power came the portable	
traction engine	трактор-тягач
multipurpose	багатофункціональний
and later the traction engine, a multipurpose	
mobile energy source	джерело мобільної енергії
heavy pulling work	важка тягова робота
took over the heavy pulling work of horses	
equipped	обладнаний
pulley	шків, блок, воріт

equipped with a pulley that could power

stationary machines	стаціонарні механізми
via	через
long belt	довгий час

stationary machines via the use of a long belt

steam-powered machines	машини на паровій тязі
low-powered	низько потужний

The steam-powered machines were low-powered

gear ratios	передаточне число

because of their size and their low gear ratios

provide	забезпечувати
crowbar	тяговий стержень, тяга

they could provide a larger crowbar pull

internal combustion engine	двигун внутрішнього згорання
petrol engine	бензиновий двигун
diesel engine	дизельний двигун

first the petrol engine, and later diesel engines

to contribute	сприяти

the engines also contributed to the development

self-propelled	само привідний гвинтовий
combined harvest	комбайно-збиральна машина
thresher	молотарка

The development of the self-propelled, combined harvest and thresher, or combine harvest.

Exercise II.

1. Вкажіть відповідний переклад речень.
2. Перекладіть слова в режимі прямого та зворотного перекладу

I

1. steam powered machines	a. передаточне число
2. stationary machines	b. довгий пас
3. gear ratio	c. стаціонарні механізми
4. internal combustion engine	d. машини на паровій тязі
5. long belt	e. двигун внутрішнього згорання

II

1. farming methods	a. коса
2. wheeled machines	b. джерело мобільної енергії
3. sharp blade	c. коліщаті пристрої (механізми)
4. portable engine	d. сільськогосподарські методи
5. mobile energy source	e. портативний двигун

III

1. combined machines	a. трактор-тягач
2. gain stalk(s)	b. домашні тварини
3. traction engine	c. стебла зернових
4. heavy pulling work	d. складні механізми
5. domesticated animals	e. важка тягова робота

Exercise III.

Заповніть пропуски відповідними за значенням словами, наведеними в таблиці.

a) threshing machines	f) multipurpose
b) agricultural machinery	g) farming methods
c) complicated machines	h) the internal combustion engine
d) portable engine	i) slow speed
e) wheeled machines	j) stationary threshing machine

1. With the coming of the Industrial Revolution and the development of more _____, _____ took a great leap forward.
2. Instead of threshing the gain by beating it with sticks, _____ separated the seeds from the heads and staiks.
3. Power for _____ was originally supplied by horses or other domesticated animals.
4. Their _____ led farmers to comment that tractors had two speeds: slow, and darn slow".
5. _____, first the petrol engine, and later diesel engines, became the main source of power for the next generation of tractors.
6. Instead of cutting the grain stalks and transporting them to a _____, these combines cut threshed, and separated the grain while moving continuously through the field.

7. With the invention of steam power came _____, and later the traction engine, _____, mobile energy source that was the ground-crawling cousin to the steam locomotive.

8. Instead of harvesting grain by hand with a sharp blade, _____ cut a continuous swath.

Exercise IV.

1. Прочитайте і перекладіть наступні словосполучення.
2. Визначте функції виділених слів і заповніть таблицю функцій II, III, IV форм дієслова (проставте номери речень)

Частина речення	II форма Past Indefinite (ed)	III форма Participle II (ed)	IV форма Participle I (ing)
Просте минуле			
Означення			
Частина присудка			
Обставина			

1) was supplied by
2) separated
3) transporting
4) complicated machines
5) farming methods
6) equipped with

Exercise V.

Прочитайте і перекладіть поданий текст.

Industrial Revolution

Part 1

With the coming of the Industrial Revolution and the development of more complicated machines, farming methods took a great leap forward. Instead of harvesting grain by hand with a sharp blade, wheeled machines cut a continuous swath. Instead of threshing the grain by beating it with sticks, threshing machines separated the seeds from the heads and stalks.

Steam power

Power for agricultural machinery was originally supplied by horses or other domesticated animals. With the invention of steam power came the portable engine, and later the traction engine, a multipurpose, mobile energy source that was the ground-crawling cousin to the steam locomotive. Agricultural steam engines took over the heavy pulling work of horses, and were also equipped with a pulley that could power stationary machines via the use of a long belt. The steam-powered machines were low-powered by today's standards but, because of their size and their low gear ratios, they could provide a large drawbar pull. Their slow speed led farmers to comment that tractors had two speeds: "slow, and darn slow."

Internal combustion engines

The internal combustion engine; first the petrol engine, and later diesel engines; became the main source of power

for the next generation of tractors. These engines also contributed to the development of the self-propelled, combined harvester and thresher, or combine harvester (also shortened to 'combine'). Instead of cutting the grain stalks and transporting them to a stationary threshing machine, these combines cut, threshed, and separated the grain while moving continuously through the field.

Exercise VI.

Доповніть речення, перекладаючи слова в дужках.

1. With the coming of the Industrial Revolution and the development of more _____ (складні механізми).
2. _____ took a great leap forward (сільськогосподарські методи)
3. Instead of harvesting grain by hand with a sharp blade, _____ cut a continuous swath (коліщаті механізми)
4. Instead of threshing the grain by beating it with sticks, _____ separated the seeds from the heads and stalks (молотарки).
5. Power for _____ was originally supplied by horses or other domesticated animals (сільськогосподарське обладнання)
6. With the invention of steam power came _____, and later the traction engine, a multipurpose, mobile

energy source that was the ground-crawling cousin to the steam locomotive (портативний двигун).

7. Agricultural steam engines took over _____ of horses, and were also equipped with a pulley that could power stationary machines via the use of a long belt (важка тягова робота).
8. The steam-powered machines were low-powered by today's standards but, because of their size and their low _____, the could provide a lager crowbar pull (передаточне число).
9. _____, first the petrol engine, and later diesel engines; became the main source of power for the next generation of tractors (двигун внутрішнього згорання).
10. Instead of cutting the grain stalks and transporting them to a _____ these combines cut, threshed and separated the grain while moving continuously through the field (стаціонарні молотарки).
11. These engines also _____ to the development of the self-propelled, combined harvester and thresher, or combine harvester (also shortened to combine) (сприяти).

Exercise VII.

Прочитайте наступні речення і вкажіть, які з них відповідають змісту тексту, а які – ні, і виправте їх.

1. With the coming of the Industrial Revolution and the development of more complicated machines, farming methods took a great leap backward.

2. Instead of harvesting grain by hand with a tractor, wheeled machines cut a continuous swath.
3. Instead of threshing separated the seeds from the heads and stalks.
4. Power for agricultural machinery was originally supplied by cows or other domesticated animals.
5. With the invention of steam power came the portable engine, and later the traction engine, a multipurpose, mobile energy source that was the ground-crawling cousin to the steam locomotive.
6. Agricultural steam engines took over the light pulling work of horses, and were also equipped with a pulley that could power stationary machines via the use of a long belt.

Exercise VIII.

Знайдіть відповідні закінчення в правій колонці до речень з лівої колонки.

1. Power for agricultural machinery	a. were low-powered
2. Agricultural steam engines	b. to the development of combine harvester
3. The steam-powered machines	c. was supplied by horses
4. These engines also contributed	d. a continuous swath
5. Whiled machines cut	e. took over the heavy pulling work

Exercise IX.

Дайте відповіді на наступні питання

1. Due to what did farming methods take a great leap forward?
2. What did wheeled machines, instead of harvesting grain by hand with a sharp blade.
3. What did threshing machines, instead of threshing the grain by beating it with sticks?
4. How was power for agricultural machinery supplied by?
5. When did portable engine, and later the traction engine, a multipurpose, mobile energy source that was the ground-crawling cousin to the steam locomotive come.
6. Why were steam-powered machines low powered by today's standards?
7. What did their slow speed had farmers to?

Exercise X.

1. Поясніть, чому посприяли різні види двигунів?
2. Перерахуйте операції комбайнів.

Unit 2

Exercise I

a) Прочитайте міжнародні слова і перекладіть їх:

modern	drill	cultivate
farm	foot	irrigation
plant	transporter	specialized
planter	plastic	pesticides
to adapt	helicopter	aerial

b) Прочитайте наступні слова і запам'ятайте їх. Перекладіть приклади їх використання *(score* 12 *points*)

harvesting job	жатва
combines might have taken the harvesting job from tractors.	
majority	більшість
tractors still do the majority of work	
implement	інвестор, пристрій
they are used to pull implements	
to till	орати
machines that till the ground	
to plant	саджати
seed	насіння
plant seed, and perform other tasks	
tillage	ораний

tillage implements prepare the soil for planting

to loose	звільняти
weed(s)	бур’ян
competing	конкуруючий

by loosening the soil and killing weeds or competing plants.

plow = plough	плуг

the best-known is the plow

to upgrade	підвищувати, покращувати

the ancient implement that was upgraded in 1838 by John Deere.

frequently	часто
formerly	у попередні роки

plows are now used less frequently in the U.S.A it than formerly.

offset	офсетний, противала
turn over	вивертати

with offset disks used instead to turn over the soil

chisel(s)	зубець
to gain	досягати
to retain moisture	зберігати вологість

and chisels used to gain the depth needed to retain moisture.

seeder	сівалка
planter	саджальник

the most common type of seeder is called a planter.

space	простір
to seed out	висівати
row	ряд

and spaces seed out equally in long rows

feet	фут (міра довжини)
apart	окремо

which are usually two to three feet apart.

drill	рядова сівалка
crops	зернові

some crops are planted by drills.

to blanket	рядова сівалка

blanketing the field with crops

transplanter	пересаджував (рослин)

transplanters automate the task

seedling	саджанець

of transplanting seeding to the field.

mulch	мульча, мульчування
plastic	глиняний
layer(s)	шар

Plastic mulch layers, transplanters and seeds lay down long rows of plastic and plant through them automatically

to spread	розповсюджувати
fertilizer	добриво

or to spread fertilizer and pesticides

hay	сіно
baler	прес (пакувальник)
tightly	щільно

hay baler can used to tightly package grass.

alfalfa	люцерна
storable form	запас

alfalfa into a storable form for the winter months.

vehicle(s)	перевізний засіб

other vehicles have been adopted for use in farming.

aerial spraying	повітряний розпилювач
livestock herd	поголів'я скота

to aerial spraying and livestock herd management.

Exercise II.

1. Вкажіть відповідний переклад речень.
2. Перекладіть слова в режимі прямого та зворотного перекладу

I

1. harvesting job	a. звільняти землю
2. implement	b. орати
3. to till	c. жатва
4. to loose soil	d. знищувати бур'яни
5. to kill weeds	e. інвентар

II

1. offset disks	a. шар глини для мульчування
2. to retain moisture	b. прес для сіна
3. shisel	c. зберігати вологість
4. plastic mulch layer	d. офсетні диски
5. hay baler	e. зубець

III

1. to seed out	a. рядова сівалка
2. to transplant seedlings	b. провітрений розпилювач
3. drill	c. пересаджувати саджанці
4. storable form	d. висівати
5. aerial spraying	e. запас

Exercise III.

Заповніть пропуски відповідними за значенням словами, наведеними в таблиці.

a) plow	f) fertilizer pesticides
b) drills	g) to put implements
c) harvesting	h) common type of seeder
d) offset disks	i) seedlings
e) plastic mulch	j) killing weeds

1. Combines might have taken the _____, away from tractors, but tractors still do the majority of work on a modern farm.

2. They are used to _____-machines that till the ground, plant seed, and perform other tasks.
3. Tillage implements prepare the soil for planting by loosening the soil and _____ or competing plants.
4. The best-known is the _____, the ancient implement that was upgraded in 1838 by John Deere.
5. Plows are now used less frequently in the U.S.A than formerly, with _____ used instead to turn over the soil, and chisels used to gain the depth needed to retain moisture.
6. The most _____ is called a planter, and spaces seed out equally in long rows, which are usually two to three feet apart.
7. Some crops are planted by _____, which put out much more seed in rows less than a foot apart, blanketing the field with crops.
8. Transplanters automate the task of transplanting _____ to the field.
9. With the widespread use of _____ plastic mulch layers, transplanters, and seeds lay down rows of plastic, and plant thought them automatically.
10. After planting, other implements can be used to cultivate weeds from between rows, or to spread _____.

Exercise IV.

Прочитайте наступні речення. Знайдіть присудок в наступних реченнях в опорі на граматичні ознаки. Перекладіть речення.

1. Combines might have taken the harvesting job away from tractors, but tractors still do the majority of work on a modern farm.
2. Tillage implements prepare the soil for planting by loosening the soil and killing weeds or competing plants.
3. Plows are now used less frequently in the U.S.A than formerly, with offset disks used instead to turn over the soil, and chisels used to gain the depth needed to retain moisture.
4. The most common type of seeder is called a planter, and spaces seeds out equally in long rows, which are usually two to three feet apart.
5. With the widespread use of plastic mulch, plastic mulch layers, transplanters, and seeders lay down long rows of plastic, and plant through them automatically.
6. After planting, other implements can be used to cultivate weeds from between rows, or to spread fertilizer and pesticides.
7. Engines, pumps and other specialized gear provide water quickly and in high volumes to large areas of land.
8. Besides the tractor, other vehicles have been adapted for use in farming, including trucks, airplanes, and

helicopters, such as for transporting crops and making equipment mobile, to aerial spraying and livestock herd management.

9. They are used to pull implement-machines that till the ground, plant seed, and perform other tasks.
10. Some crops are planted by hands, which put out much more seed in rows less than a foot apart, blanketing the field with crops.

Exercise V.

Прочитайте текст та перекладіть його за допомогою словника.

A 1963 Ford 600 farm truck

Combines might have taken the harvesting job away from tractors, but tractors still do the majority of work on a modern farm. They are used to pull implements—machines that till the ground, plant seed, and perform other tasks.

Tillage implements prepare the soil for planting by loosening the soil and killing weeds or competing plants. The best-known is the plow, the ancient implement that was upgraded in 1838 by John Deere. Plows are now used less frequently in the U.S. than formerly, with offset disks used instead to turn over the soil, and chisels used to gain the depth needed to retain moisture.

The most common type of seeder is called a planter, and spaces seeds out equally in long rows, which are usually two to three feet apart. Some crops are planted by drills, which put out much more seed in rows less than a foot apart, blanketing the field with crops. Transplanters automate the task of transplanting seedlings to the field. With the widespread use of plastic mulch, plastic mulch layers, transplanters, and seeders lay down long rows of plastic, and plant through them automatically.

After planting, other implements can be used to cultivate weeds from between rows, or to spread fertilizer and pesticides. Hay balers can be used to tightly package grass or alfalfa into a storable form for the winter months.

Modern irrigation relies on machinery. Engines, pumps and other specialized gear provide water quickly and in high volumes to large areas of land. Similar types of equipment can be used to deliver fertilizers and pesticides.

Besides the tractor, other vehicles have been adapted for use in farming, including trucks, airplanes, and helicopters, such as for transporting crops and making equipment mobile, to aerial spraying and livestock herd management.

Exercise VI.

Доповніть речення, перекладаючи слова в дужках.

1. Combines might have taken _____, away from tractors, but tractors still do the majority of work on a modern farm. *(жатва)*
2. They are used to pull _____-machines that till the ground, plant seed, and perform other tasks. *(інветнар)*
3. Tillage implements prepare the soil for planting by loosening the soil and _____ or competing plants. *(ораний)*
4. The best-known is the _____, the ancient implement that was upgraded in 1838 by John Deere. *(плуг)*
5. Plows are now used less frequently in the U.S.A than formerly, with _____ used instead to turn over the soil, and chisels used to gain the depth needed to retain moisture. *(офсетні диски)*
6. The most _____ is called a planter, and spaces seed out equally in long rows, which are usually two to three feet apart. *(сівалка)*
7. Some crops are planted by _____, which put out much more seed in rows less than a foot apart, blanketing the field with crops. *(рядова сівалка)*
8. With the widespread use of _____ plastic mulch layers, transplanters, and seeds lay down rows of plastic, and plant thought them automatically. *(мульча)*
9. After planting, other implements can be used to cultivate weeds from between rows, or to spread _____. *(добрива та пестициди)*

10. Besides the tractor, other vehicles have been adapted for use in farming, including trucks, airplanes, and helicopters, such as for transporting crops and making equipment mobile, to _____ and livestock herd management. *(повітряне розпилення)*

Exercise VII.

Прочитайте наступні речення і вкажіть, яки з них відповідають змісту тексту, а які ні, і виправте їх.

1. Combines might have taken the harvesting job away from tractors, but tractors still do the majority of work on a modern farm.
2. They are used to pull implement-machines that till the ground, plant seed, and perform other tasks.
3. Harvesting implements prepare the soil for planting by loosening the soil and killing weeds or completing plants.
4. The best-known is the plow, the ancient implement that was upgraded in 1838 by John Deere.
5. Tractors are now used less frequently in the U.S.A than formerly, with offset disks used instead to turn over the soil, and chisels used to gain the depth needed to retain moisture.
6. The oldest type of seeder is called a planter, and spaces seed out equally in long rows, which are usually two to three feet apart.

7. Some crops are planted by hands, which put out much more seed in rows less than a foot apart, blanketing the field with crops.
8. Transplanters automate the task of transplanting seedlings to the field.
9. Before planting, other implements can be used to cultivate weeds from between rows, or to spread fertilizer or pesticides.
10. Besides the tractor, other vehicles have been adapted for use in farming, including trucks, airplanes, and helicopters, such as for transporting crops and making equipment mobile, to aerial spraying and livestock herd management.

Exercise VIII.

Знайдіть відповідні значення в правій колонці до речень з лівої колонки.

1) Combines might have taken	a) less frequently in the U.S.A
2) They are used to pull implement	b) relies on machinery
3) Plows are now used	c) the harvesting job away from tractors
4) Transplanters automate	d) the task of transplanting
5) Modern irrigation	e) machines that till the ground

Exercise IX.

Дайте відповіді на наступні запитання.

1. What are combines used to do?
2. What do tillage implements prepare?
3. Which implements is the best-known one?
4. How often are plows how used in the U.S.A?
5. How is the most common type of seeder called?
6. Are all crops planted by drills?
7. What do transplanters automate?
8. When can other implements by used to cultivate weeds from between rows?
9. What can hay balers be used for?
10. What does modern irrigation region?

Additional texts for reading.

Прочитайте текст та перекладіть його зі словником.

New technology and the future

Though modern harvesters and planters will do a better job than their predecessors, the combine of today still cuts, threshes, and separates grain in essentially the same way it has always been done. However, technology is changing the way that humans operate the machines, as computer monitoring systems, GPS locators, and self-steer programs allow the most advanced tractors and implements to be more precise and less wasteful in the use of fuel, seed, or fertilizer. In the foreseeable future, some agricultural machines will be capable of driving themselves, using GPS maps and electronic sensors to become agricultural robots. Even more esoteric are the new areas of nanotechnology and genetic engineering, where submicroscopic devices and biological processes may be used as machines to perform agricultural tasks.

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Fields of automation

Robotics: A new generation of agricultural equipment promises to take more of the toil out of farming by automating the business of growing fruit

Agricultural robots

Inspecting a tomato plant at MIT Jason Dorfman.

In the early 1830s, spurred on by his hatred of sweaty field work, Cyrus McCormick took an idea his father had been working on at the family farm in Virginia and produced a mechanical reaper. Others devised similar machines. Despite initial scepticism, farmers eventually bought them in droves. With one person riding the horse that pulled the reaper, and another raking the cut stalks off the back, the machines could harvest as much grain in a day as a dozen men breaking their backs with reaping hooks.

Mechanical reapers became even more efficient when adapted to bale the stalks into sheaves, too. Development continued: today a driver in the air-conditioned cabin of a combine harvester may be guided by satellites as he cuts, threshes and pours clean grain into a fleet of accompanying trailers. One machine, the New Holland CR9090, holds the record after harvesting a colossal 551 tonnes of wheat in just eight hours from a farm in Britain in 2008. Given that such machines cost around £350,000 ($580,000), agricultural automation must make economic sense—because farmers don't spend money on frivolities.

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But there are farms where people like McCormick still dream of taking hard, manual work out of agriculture. These farms grow crops that mostly have to be tended and picked by hand, such as apples, oranges and strawberries. In rich countries it is becoming increasingly difficult to find people to do this at wages farmers say they can afford. Seasonal demand adds to the problems: in California, where some

450,000 people, mostly immigrants, are employed on fruit farms at the peak of the harvest, growers often leave some produce to rot. Even Japan's exquisite and expensive strawberries are becoming too costly to pick because of a shortage of workers, in part caused by an ageing population. Despite worries about food shortages in the coming years, many farmers are more worried about labour shortages.

Just as the mechanical reaper transformed the economics of cereal farming, a new wave of agricultural automation promises to do the same in other areas of horticulture. Because picking apples is very different to plucking strawberries, the machines are taking various forms. Some have giant mechanical arms and are towed behind tractors through orchards and vineyards. Some are fully autonomous and able to scurry around on their own, even in paddy fields, like the robotic rice-planter developed by Japan's National Agricultural Research Centre. Others trundle about inside experimental greenhouses.

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Whatever shape they come in, agribots share several underlying technological advances which have their origins in factories. Automating factories is easier than automating farms, which are far less predictable environments: the weather constantly changes, the light alters, the ground can turn from grass to mud, and there are animals and people wandering around. Moreover, unlike car parts, fruit does not come in standard sizes. It moves around on branches in the wind, changes shape and colour, and can be hidden by

leaves. But improvements in vision and other sensing systems, coupled with the increase in the power of computing, have made robots cleverer, safer and more dexterous.

Yet farmers, like factory owners, will want a return on their investment. “It is actually not hard to pick an orange, but it is very hard to pick an orange cost effectively,” says Tony Stentz of the Robotics Institute at Carnegie Mellon University in Pittsburgh. Because robots can work all day without a break, they have one advantage over manual labour. But it is their potential for accurate information-gathering that is proving to be an equally important talent.

Crop-tending robots that use vision systems, laser sensors, satellite positioning and instruments to measure things like humidity can build up a database of information about each plant. This can be used to detect the onset of disease, says Dr Stentz. A “smart sprayer” can then deliver precise amounts of chemical to only those plants that require attention instead of spraying an entire field. By observing the development of each plan, crop yields can be predicted more accurately. Automated harvesters will then use the database to identify and gather individual produce whenever it is ready for harvest.

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On a small scale it is already possible to see fully automated horticulture in action. The Massachusetts Institute of Technology (MIT) has an experimental greenhouse growing cherry tomatoes on raised platforms. It

is managed entirely by small robots. Each plant is equipped with sensors which keep track of its condition. If a particular plant is getting a bit dry, one of the robots is summoned to water it. When a tomato is identified as being ripe, the robot uses its vision system to locate the fruit on the vine and pick it with a mechanical arm.

Daniela Rus, director of MIT's Distributed Robotics Laboratory, says there are a number of ways in which automated systems could improve crops and "remove some of the hard tedious work from greenhouses". A plant-centred system using sensors would record not just an individual plant's progress but also the condition of the soil it is growing in. If nutrients are needed they can be delivered precisely, which would cut down on inputs.

Greater mechanisation may prompt farmers to change some of their ways and the varieties they grow. An example is Californian raisins, which are traditionally harvested by hand. Workers cut off bunches of grapes and lay them on trays between the rows to dry. As many as 50,000 people used to be required for the harvest. But due in part to declining acreage and increased mechanisation, that has now fallen to 20,000-30,000.

Robotic research bears fruit. Vision Robotics/Jason Dorfman

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Mechanisation has come about in a number of ways, according to a report by Philip Martin of the University of California, Davis. Growers, sometimes using varieties that reach optimal sugar levels earlier, slice the canes holding the

bunches of grapes so they begin to dry while still on the vine. Modified grape harvesters with rotating fingers then knock off the raisins. If completely dry they are gathered immediately, and if not they are laid onto a continuous paper tray in the vineyard to dry.

About 35% of Californian raisins were harvested in 2008 using the continuous-tray system and another 15% dried completely on the vine. The university reckons the traditional hand-harvesting method cost $494 an acre in 2006, compared with $282 an acre in 2008 for the mechanised continuous-tray method. Newly planted vineyards could be even more efficient by using a higher density of vines trained to grow over trellises designed to help with mechanical severing and harvesting.

Even pruning can be mechanised. Vision Robotics, a company based in San Diego, has demonstrated a prototype vine-pruning robot. Good pruning requires skill to balance the growth of the vine. The vines also need to be trimmed at certain locations and at precise angles to grow the best grapes for winemaking. The robot is a bit slower than a good human pruner, but it will speed up. It should be able to prune vines at about half the cost of manual labour, says Derek Morikawa, the chief executive of Vision Robotics.

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The company is also developing apple- and orange-picking robots with multiple arms. These too rely on building 3-D models of trees and the fruit growing on them. Mr Morikawa thinks the crop-scouting ability of such

automated machines will prove highly valuable. Supermarkets, for instance, like uniformity so if they want, say, apples of a certain size and in a particular state of ripeness, a farmer could use the model to identify exactly where such apples are growing.

The take-up of mechanisation will depend on where the produce is going and how carefully machines can pick it. Light bruising from mechanical harvesting may be acceptable for fruit going to the juicer, but not for fruit displayed on a supermarket aisle. Even though grape harvesters, which shake or knock grapes from vines, have been around for about 40 years, some growers still pick by hand.

To compete with hand-picking, robot harvesters will need to twist, pluck, cut or suck produce from stems and handle it as gently as possible. Many factory robots are already capable of doing things like this, and some already sort soft fruit passing along conveyor belts. But operating outside on a farm is much harder. For one thing, lightweight mechanical arms are needed to reach high into trees and pick with precision, despite wind and uneven terrain. Inside a sheltered greenhouse, however, robots feel more at home.

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Oranges are not the only fruit

One of the most difficult challenges is to produce a strawberry-picking robot. Strawberries are delicate and go through different shades of red while they ripen on the vine. Moreover, they ripen at different times. There are strawberry harvesting machines, but they are mostly towed

contraptions on which people lie down in order to pluck berries. But researchers at Miyazaki University and Kyoto University in Japan are working on robot versions.

These are designed to operate in greenhouses adapted to automation. The strawberry plants grow on raised beds and the robots travel between them on rails. They rely on machine vision to determine when individual berries are ripe, cutting them from the plant and holding them with a gentle suction as they transfer them to a conveyor belt or basket. These robots are not yet as fast as human strawberry pickers, but they can work all day and all night.

This might seem to be an elaborate way to grow strawberries—as well as an expensive one. So it is no surprise that when Japanese growers were asked in a survey if they wanted such a system only a little more than 6% said they did. However, more than half thought they might need one in the future. Other farmers around the world are likely to agree with Japan's strawberry growers. Agribots will, like McCormick's mechanical reaper, face a lot of initial scepticism. But planting and picking they will come.

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Automation of Hatching Egg Collection is Important to Broiler Breeder

Maximising hatchability and minimising floor eggs are the two most important criteria when equipping a new broiler breeder house, farmer Anton Janssen told ThePoultrySite editor, Jackie Linden when she visited his farm recently.

At his farm in Reusel in the province of North Brabant in the south of the Netherlands, Anton Janssen houses broiler breeders. In total, he now has 45,000 Ross 308 females and 4,500 males on farm.

The latest expansion at Mr Janssen's farm is a new-build house for a total number of 13,500 birds – 12,200 females and 1,300 males. For the equipment of this new house, Mr Janssen worked in close cooperation with poultry equipment supplier, Vencomatic.

Together with Vencomatic, Mr Janssen looked at every detail to improve hatchability and minimise floor eggs. At the time of the visit to the farm, the birds were 41 weeks of age, and where laying at a rate of 78.5 per cent with less than one per cent floor eggs.

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Every Egg Counts

In today's broiler breeder operations, a small margin is made. It is important that no egg are lost and the maximum number of hatching eggs is delivered to the hatchery. This is the only way to survive and keep operations profitable.

Mr Janssen stressed the importance of a good nest box. "The nest should be attractive for the hen, so that all eggs are being laid in the nest. This not only reduces labour for collecting the eggs from the floor, but also decreases the chance for eggs to become dirty." As the floor egg percentage in his new house is lower than in the other existing houses, it seems the birds like the new Vencomatic nest.

The main reason to choose for the Vencomatic nest box where the tipping floors of the nest. With these tipping floors, birds are expelled from the nest, which prevents them littering the nest at night. The tipping floor also cleans the nest flooring, as all dirt and litter falls from the floors, when tipped. In this way, the nest always provides a clean and hygienic place for eggs to be laid.

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Hatchability is No. 1 Concern

Hatchability is Mr Janssen's top priority, as this partly determines his income, which is based on a certain minimum hatchability, with a bonus for higher hatchability. His current partner is Belgium-based broiler hatchery Spoormans, which also provides Mr Janssen with pullets and feed.

In order to stimulate mating behaviour with his males, the house is equipped with winchable feeding lines. After feeding, the lines are winched, which provides more space for movement and mating.

Controlling feed intake is vital for broiler breeders to stop the birds becoming too heavy to breed. The males have special feeding lines. The birds at Janssens' farm are fed once a day, directly after the lights are put on in the morning. The hens get to eat first, followed by the males, 10 minutes later.

Next to male management, gentle egg collection is important for a good hatchability. Any hair cracks or other mechanical damages may cause a decreased hatchability and

even exploding eggs in the hatcher. For this reason, Mr Janssen asked Vencomatic to take care of the complete egg collection, from the moment the egg leaves the hen until it is placed on the setter tray.

With the PSPC packer from Vencomatic's sister company Prinzen, the eggs are all being put on the setter trays with points down. This also has a positive effect on hatchability.

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Maximising Efficiency of Labour

As the farm of Mr Janssen is a family-run business, it is very important for him to automate as much as possible. He and his wife are collecting the eggs together but also need to look after the birds and have time for other day-to-day business. The family only gets help for catching and cleaning the house.

"Fully automated egg collection and fewer floor eggs in the new house saves time for other important work on the farm," commented Mr Janssen. "Without the solutions from Vencomatic, we probably couldn't handle our current flock size and would need to get an employee to help with egg collection."

To keep diseases out, the farm operates an all-in, all-out policy, with the houses empty during the month of August. There are regular monthly visits from a breeding company veterinarian and also from another vet who covers exports as Mr Janssen's eggs are sent across the border to Belgium.

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Tom Shelley reports on a how a machine based on factory automation technology is set to revolutionise agriculture

Able to take vegetable seedlings from trays and plant them in a field at up to 20 per second, a new machine applies factory automation concepts and equipment to products that are soft and delicate, each slightly different from every other, and sometimes separate and sometimes entangled.

The machine was originally conceived by three brothers in a family nursery business but it has since taken 10 years, millions of pounds, and a lot of effort by a UK manufacturer of agricultural equipment – backed by a leading maker of factory automation equipment – to bring it to market.

Missing plants, or those failing to thrive, are automatically detected and healthy plants put in their place, resulting in higher crop yields. Machines are already in service in the UK and the US and point the way forward to machine processing of even the most variable and difficult to handle products.

Eureka saw the machine at work in a field in Lincolnshire, planting a large field full of brassica seedlings (brassicas are vegetables such as cabbages, cauliflowers and broccoli) in a few hours, with the help of only three men: one driving the tractor and two on the back, putting trays of seedlings on the input platforms in time for telescoping pneumatic cylinders to push them into the seedling grasping

and handling system. The task would have at one time required the efforts of a gang of people working over several days.

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Phillip Bosworth, marketing and sales director of Boston-based developer, Richard Pearson, told us that even with a modern semi-automated equipment, such a task requires plenty of labour.

"It would need around 13 people on a 10-row gang – mainly to take the seedlings out of the trays," he said. "This machine can do 20-30 acres per day, selecting four plants per second on five heads and running forward at 4miles per hour."

Bosworth added: "You have to have a very sophisticated system to be able to do this", indicating the large industrial enclosure of computing equipment on the platform of the machine. "The system has control of the module [the plant in its piece of earth] from the moment it is picked. The Mitsubishi computer system controls every movement of the mechanism – the speed of the heads, the actuators, the braked servo motors and the picking pauses".

The company seems impressed with the parts and support they have received from Mitsubishi Industrial Automation Systems Division. Its website describes Mitsubishi as "a market leading supplier with a superb reputation for high quality, reliable components".

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The modules are grown in standard rigid trays with a separate, slightly tapered square aperture for each seedling. The modules are grasped and lifted out a row at time.

Four steel fingers go in and pick each module. A carbon fibre rod pushes a plastic block to open the fingers. Then as the fingers are pushed into the module, the block is retracted upwards, allowing the fingers to grip the module.

"We call this our 'positive pick'," said Bosworth.

Once it is in the pick fingers, the module is retracted from the cell. The head assembly then moves a full row of modules horizontally until it is over one of two flighted belts. The carbon fibre rods, which run in carbon fibre finger tubes, then push each module into a place between a pair of nylon flights. The head assembly then retracts vertically. While one flighted belt is being charged, the other is delivering plants, controlled by a clutch assembly, which is controlled whenever a plant without foliage is detected by the optical sensor as being absent. High forward speed of the machine is possible because one belt is charging while the other belt is feeding. The clutch assembly allows a maximum speed of 12 plants per second.

Within a given row of plants – if planting four plants per second – it is possible to make up for up to three dead cells or plants without foliage. This is important for growers because present practice is for somebody to come along after a field has been machine planted and put plants into the gaps by hand. These plants, however, having been planted

later, do not grow in step with the others, causing problems later when it comes to harvesting for supermarkets.

"A switchover mechanism ensures that each plant is accurately delivered from one of the flighted belts to the sweet spot between the delivery belts," said Bosworth. "The delivery belt assembly is made up of two foam covered endless belts, which are also controlled by the computer and delivered into the ground. A strong coulter opens the soil, and as the soil flows round the back of the coulter, the plant is put in and two circular press wheels firm the plant in place."

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R Fountain and Sons is a family owned company with 20 acres of glasshouse nurseries. The company started construction of its Mark 1 prototype machine in 2000, and tested it in 2001. A second Mark 2 machine was built and tested in 2002. The five-head, Mark 3 machine was able to plant over 500 acres of different brassica varieties in 2003 in a variety of soil conditions. In 2004, a worldwide licensing agreement was signed with a local company, Richard Pearson, which has been in business of making agricultural machinery since 1955.

Bosworth told us: "In 2004, we started productionising Fountain's prototype, and the two companies then cooperated to build two machines – which we upgraded and modified for the 2006 season. The Fountain machine did 1250 acres from 1 April to 31 July 2006. In the same year, we also shipped a machine to the USA for tomatoes. It is now working well in California and we are now receiving

many strong enquiries for machines manly to plant tomatoes and brassicas.”

A modem allows Pearson to monitor the performances of machines remotely and to carry out diagnostics and remote programming if required. The main moving parts need no lubrication. Entrapped dust and other material is removed by blowing down with compressed air.

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"The Institute of Agricultural Machinery at Japan's National Agriculture and Food Research Organization, along with SI Seiko, has developed a robot that can select and harvest strawberries based on their color. Ripened berries are detected using the robot's stereoscopic cameras, and analyzed to measure how red they appear. When the fruit is ready to come off the vine, the robot quickly locates it in 3D space and cuts it free. From observation to collection, the harvesting process takes about 9 seconds per berry. Creators estimate that it will be able to cut down harvesting time by 40%."

With multiple cameras and sharp pincers, this robot resembles an insect pest. However, it could help revolutionize fruit picking.

It takes more than a green thumb to be a great farmer, super-human vision helps as well. The Institute of

Agricultural Machinery at Japan's National Agriculture and Food Research Organization, along with SI Seiko, has developed a robot that can select and harvest strawberries based on their color. Ripened berries are detected using the robot's stereoscopic cameras, and analyzed to measure how red they appear. When the fruit is ready to come off the vine, the robot quickly locates it in 3D space and cuts it free. From observation to collection, the harvesting process takes about 9 seconds per berry. Creators estimate that it will be able to cut down harvesting time by 40%. Prototypes are currently being tested in the field with marketable versions expected in the next few years. This artificial agriculturalist was recently recognized by the 4th Annual Robot Award of the Year in Japan. You can see why in the videos below. If we adapt its combination of visual acuity and manual dexterity for other produce, the strawberry harvesting robot could help reshape industrial agriculture.

A typical berry field one square kilometer in size takes about 500 hours to harvest. With its speedy evaluation, the strawberry picking robot could cut this down to around 300 hours. Not only that, but every berry would have a quantifiably similar level of ripeness based on color, and would be harvested with a minimum of bruising. Robots will also be able to harvest during the night (as shown in the videos below) allowing for the fruit to reach market closer to optimum freshness. These improvements in speed and quality will likely translate to millions of dollars saved each year for the industry as a whole. Even if we focus on strawberries alone, robots like this one make a lot of sense.

DigInfo's coverage has a great interview with an IAM representative from NARO, and shows how the robot views the fruit it picks for harvest:

Of course, the real potential of this robot extends far outside harvesting just strawberries. Berries have a relatively high value per fruit, and can be raised in controlled conditions very well, so they are an ideal first test case. Clearly, however, the lessons that NARO is learning with the strawberry robot are going to apply to tomatoes, grapes, and many other plants with similar anatomies. Crop selection based on color would be useful for almost all fruits, as well as many other forms of produce. Stereoscopic vision, which allows the robot to accurately locate the fruit in 3D space and remove it without damage, could help with any agricultural project, and is a big part of the robotics industry as a whole.

We've seen other projects which highlight the potential of robots in the gardens, fields, and farms of the world. MIT developed prototype bots that could monitor, feed, and harvest tomato plants. Robots have been an important part of dairy farming, and continue to increase in scale and skill. Such machines allow humans to fill management roles and let robots maintain cheaper, healthier, and more valuable crops.

The automation of agriculture could prove to be a pivotal development in the early 21st century, akin to the adoption of combustion engines in the early 20th century. Just as horses were eventually replaced by tractors, humans may find themselves replaced by robots in the remaining realms of agricultural labor in which they still hold sway.

It will be a few years, however, before NARO's strawberry robot is threatening anyone's job. Yes, the sophistication of the bot is wonderful to behold, but the device is still in field tests. Developers will need to finish that research, redesign the robot accordingly, and then market the device. Who knows how long it would take it to hit the global agricultural industry. That's assuming, of course, that the robot's costs (for electrical power, maintenance, etc) are low enough not to interfere with the benefits it produces in harvest effeciency and quality.

Given enough time, however, it will make economic sense to pick berries with robots rather than humans. The history of industrial agriculture teaches us that if a worker can be replaced by a machine, they will be. Yet despite the obvious disruptions this causes in employment, I think the eventual move towards robotic agriculture is a vital one. We are still fighting global hunger, and anything that can increase our productivity and efficiency in agriculture is likely a valuable step towards solving that grand challenge. The strawberry robot is a relatively small development, but it's a good one.