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Effect of Frequently Turning on Some Composting Processes for Agricultural Residuals

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ABSTRACT

This study was carried out in one of compost factories in Sadat city Menoufia, Governorate in 2011. Basically these studies aimed to identify engineering studies on agricultural residuals recycling. These agricultural residuals are: Fields wastes (shredded rice straw), Animals wastes (manure) and Food processing wastes, sugar cane factories wastes (press-mud). The composting was aerobic; the mechanical turning was done by turning machine which traced with tractor by the rear shaft PTO. Then temperature, moisture content, reducing ratio, composting period and final product were measured. From results found, the temperature reaches its maximum quickly when piles turning three times per week for all piles, the moisture content decrease with increasing the composting period and frequently turning, the reducing ratio decrease with decrease the composting period, the higher product was at the higher frequently turning and the composting period was decrease with increasing the frequently turning.

INTRODUCTION

The top of three residues represent a significant burden on the Egyptian conditions were lacking under study and analysis.

They are; Rice straw as field residues, Press-mud as a sugar industry organic waste and finally, Cattle manure.

Average production of rice about 6.12 million tons per year and 9.5 tons per hectare in 2005, FAO (2006). Egypt is the largest producer of rice in Africa, with supplying 5.9 million tons of rice in 2013 (more than 22% of rice production in Africa). It is estimate that about 3.1 million tons/year of rice straw are disposed by direct burning in open field causing environmental problems, FAO (2013). The abundance of rice straw as an organic waste could be converting to fertilizer throughout the process of composting, Tiquia and Tam (2002).

Press-mud can serve as a good source of organic manure, Bokhtiar *et al.* (2001) which is rich in various essential nutrients. Dry matter, cane and sugar yields increase with increasing nitrogen and press-mud or filter-cake rate, Bangar *et al.* (2000). The C/N ratio needed for effective composting is between 25 and 40, depending on the particular organic substance. The C/N ratio of filter cake is approximately 14, but for bagasse, it is approximately 100. Therefore, the composting of filter-cake may result in considerable N loss, but N must be adding to promote composting of bagasse, Bernal *et al.* (1998), Wu *et al.* (2000), and Itavaara *et al.* (2002).

Cattle manure is a rich in nitrogen and wet material. The moisture content and C/N ratio depend on the amount of bedding used, the management practices and climate. Normally it requires a large amount of dry high carbon amendment, FAO (2007). Residue of temperature phased anaerobic digestion for methane generation. Such waste can become a source of pollution and threat to public health if they are not properly handled and disposed. Therefore, converting cattle-manure-compost into activated carbon is a good strategy to overcome the previously mentioned problems and could be used to mitigate other pollutions, Qian *et al.* (2009).

Composting is done aerobically then some mechanical operations are carried out like turning by turning equipment for certain intervals with being affected by temperature and moisture. Then studying effected turning processes on composting period, temperature, moisture content and reducing ratio.

Therefore the main aim of study is to investigate the effect of turning times on the compost process and quality.

MATERIALS AND METHODS

This experiment was carried out in compost factories (EL- Menoufia for fertilizers and chemicals Factory) at Sadat City, Menoufia governorate, Egypt during period from March 2011 till the end of July 2011.

- Three types of residuals mixture is used, manure only, mix (manure with rice straw with ratio 1:1) and mix (manure with press mud with ratio 1: 1).
- Three frequently turning one time per week, two times per week and three times per week.

Raw materials

Rice straw has been collected as medium balls then send to the factory to drying and shredded by shredded machines. It has been shredded into pieces 2-5 cm. The chemical composition of rice straw has been determined before was used in the experiment, rice straw elements, moisture, ash, protein, (total nitrogen content x 5.7).

Basically manure contents of bedding under animals contents of rice straw, saw dust wastes, rice crashes, beans hays, wheat hays, silage and some re-manning chicken litter proportion which estimated about 10 to 15 % from total size of manure used in composting processes.

The main kind of food wastes is sugar cane press-mud. During the sugar production process in the mill, a number of by-products and residues are generated. These are:

- Bagasse, which is the fibrous material remaining after chopping and milling from juice extraction.
- Filter-cake/press-mud resulting from cane juice filtration.
- Furnace ash, in case the bagasse is burnt in the boiler for steam and electricity generation.

The main kind of sugar cane wastes has been used was press-mud. press-mud is a waste containing 1.8% total N, organic matter 48%, C/N ratio 14, total-P 0.96%, total- K 0.39%, total Ca 7.1%, total-Mg 0.40%, pH 7.7, EC 0.80 dS/m and ash 52%.

Composting processes

In this study the major way is used for composting the loader and manure shredders. The pile is 2.5 × 1.2 ×150 m width, height and length respectively.

The wastes are mixed directly with each other like manure and hays. Crushed hays, livestock, baggas and some wastes are the basic beddings in besides are mixed.

Turning the Pile: Turning for all the piles were done with especially machine. Its dimensions are 1.5 meter high and 2.5 meter width. It has weight 2 ton to make balance during working and two hydraulic pistons to raise its in case when return from pile to another pile. The equipment is operated by tractors with powers of 90 and speed of 0.85 – 1.0 km/h. They are turned by the back turning post of the tractor PTO. Some tanks on balanced Wight for machine to add water and some biological materials like effective micro-organisms (EM) during turning processes.

Measurements was taken through composting at beginning forming piles composting period, reducing ratio, moisture content, temperatures and following changes for piles volume for three type of compos (manure, mix manure with rice straw and mix manure with press-mud).

During preparing the raw materials and manufacturing the, two moisture content methods were counted.

- Before forming piles the all wastes was watered to reach the moisture content 55to 60%.
- At end of composting period and stability of piles the moisture content was determined at laboratory by this equation:

Wc × 100 (% w/w wet basis)

Where:

Wo, g. Weigh empty container

W oc, g. Fill with material (100 - 200 g) and weigh.

Wocd, g. Weigh dried sample and container.

$$100 - \frac{(Wocd - Wo)}{(Woc - Wo)} \times 100$$

Where dry sample in oven at 100°C for 3 days.

The compost temperature was recorded using the thermometers which made in German model 2006, it 0.90 meter long, manufactured from stainless steel, mercurial gage. Using a 60 or 90 cm stem dial thermometer take the temperature of the pile at approximately 30 and 90 cm depths in at least two locations of the pile. Leave the thermometer in place long enough for the reading to stabilize. Record these temperatures.

Reducing ratio was calculated by difference between two volumes; the volume at beginning composting for the piles and the volume at the end of composting (at stability of piles).

RESULES AND DISCUSSION

Manure piles: Statistics was carried out for temperatures piles at 15th, 30th, 45th and 60th days from beginning composting. The SPSS program indicated that there are significances differences between the three types of frequently turning and the composting period. Also there is a significance difference of using the all of three frequently turning at the 15th day. But there is no significance at 30th, 45th and 60th days for turning manure piles with temperature Table (1).

Table (1) The numbers of turning manure pile and properties.

Factors	Frequently turning one time per week	Frequently turning two times per week	Frequently turning three times per week
Numbers of turning for pile	12 times	15 times	20 times
Maximum ^{o}C/ day	70 C^{o} / 45day	70 C^{o} / 21day	70 C^{o} / 19day
Stability ^{o}C /day	45 C^{o} / 80day	45 C^{o} / 45day	45 C^{o} / 41day
Moisture%1&2	(55- 60) &35	(55 - 60) & 30	(55 - 60) & 25
Final product m^3	152 m^3	152 m^3	154.4 m^3
Reducing ratio%	34	35	34
Final compost after screening on sieve 1inch m^3	134m^3	142.6 m^3	147 m^3
Residual ratio%	11.8	6.5	5
Bulk density kg/m^3	712	740	720

Numbers of turning for the pile = the frequently turning for pile from beginning rising temperature and its stability.
Maximum C^{o}/ day =the day which at it temperature reach its maximum.
Maximum C^{o}/ day = the day which at it temperature reach its stability.
Moisture 1&2 = moisture content was recorded at beginning and end of composting period %.
Final product = final compost which produced form manure pile after stability with m^3.
Final compost after screening on sieve 1-inch = final compost which produced manure pile after stability with m^3.
Residual ratio = amount residual which output from the sieves 1-inch %.

For the composting period, there is a significance difference for all frequently turning per week. The recorded temperature for the manure pile with frequently two times presented also in the Table (1). It reached its maximum at the twenty-one day whither, continued for two week approximately and reaches its stability at the forty-five day after frequently turning 15 times through composting processes (Tiquia *et al*. 1997).

The recorded temperature for the manure pile with frequently one time was reach its maximum at the forty-five day whither, continued for a week approximately and reach its stability at the eighty day after frequently turning twelve times through composting processes. This was also presented in the table and also in figure (1).

The temperature rising quickly, at turning three times per week. It reaches to its maximum after nineteen days. Therefore, it declined quickly however it reaches to its stability at the day of forty-one and after twenty times of frequently turning.

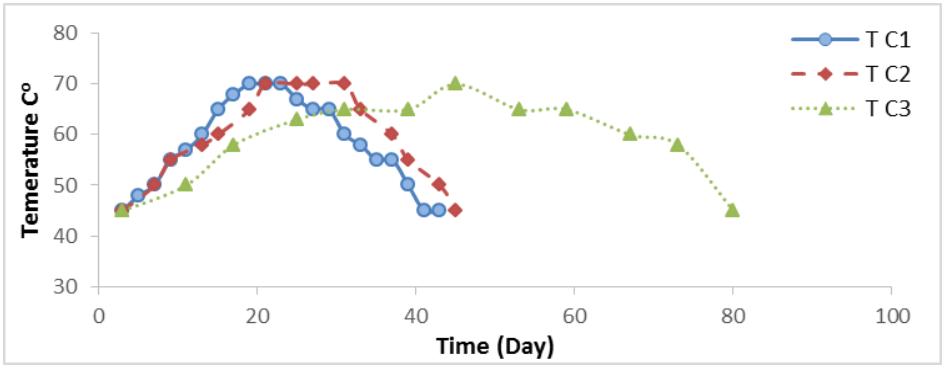

Figure (1) Recorded temperature for manure pile.

T° C 1 turning manure pile three times per week
T° C2 turning manure pile two times per week
T° C3 turning manure pile one time per week

However, when turning was two times per week the temperature rise moderately and declined moderately. Also it reaches to its maximum at twenty-one days and reaches its stability at forty-fife day and after fifteen times of frequently turning

Nevertheless, at turning, one time per week temperature rises slowly and it was declined slowly however, it was reach its maximum after forty-fife day and reach its stability at eighty days and after twelve times of frequently turning. Ogunwande *et al*. (2008); Wong *et al*. (2001) and Desta and Ali (2009), reported turning two times a week resulted in higher temperature and faster decomposition than turning once a week or once every other week.Considering the costs and time, it was found that the best frequently turning is two times per week.

The moisture was equal in value when it recorded at the beginning of the composting. After stability for three experiments, it was recorded 25% & 30% & 35% for frequently turning three, two and one time per week respectively (Table 1). This means that increasing the frequently turning adversely affect the moisture content this accepted with Ogunwande *et al*. (2008) which said, increase in moisture loss was associated with increase in turning frequently.

Mix manure and rice straw: From the table (2) and Fig.(2) it was found that, No big different between frequently turning three times and two times per week with number of turning 30-20 times in period 57-61day. However, the same time approximately which temperature was recorded. The maximum was found at 72° C at the day of 39 and 70° C at the day of 30 during turning three times and two times respectively. It was recorded its stability 45° C at the day of 61 and 45° C at the day of 57 day respectively.

The moisture was equal in value when it recorded at the beginning of the composting 55-60%. Initial moisture content was 50 to 60% in all composting piles and according to (Gajalakshmi and Abbasi, 2008) this range is fit for ideal composting process.

Pile temperatures and composting period, after stability for three experiments, it was recorded 20% - 22% and 16% for frequently turning three, two and one time per week respectively. The time has a big effect on the moisture content however; at frequently turning three times the moisture was recorded 20% on time 61 day and it was recorded for frequently two times 22% on time 57 day but at the frequently one time was 16% on time 115 day.

Reducing ratio, the reducing ratio was influenced by the time however; it was 59%, 58% and 62% foe frequently turning three, two and one time per week respectively. The reduction in total organic matter during composting process, mostly due to the degradation of easily degradable compounds such as proteins, cellulose and hemi-cellulose, which is utilized by microorganisms as carbon and nitrogen, sources (Barington *et al.*, 2002). In this treatment cannot screening. However, during screening at the first cubic meter from compost the sieve was closed with the compost because of its high spongy structure and ratio of waste plants was high. It was fifty percent in addition it don't falls from the sieve 1-inch.

Table (2) The numbers of pile turning and piles properties.

Factors	Frequently turning one time per week	Frequently turning two times per week	Frequently turning three times per week
Numbers of turning for pile	17 times	19 times	30 times
Maximum °C/ day	60 C° / 59day	70 C° / 30day	72 C° / 39day
Stability °C /day	45 C° / 115day	45 C° / 57day	45 C° / 61day
Moisture%1&2	(55 - 60) & 16	(55 - 60) & 22	(55 - 60)&20
Final product m^3	67 m^3	75 m^3	73 m^3
Reducing ratio%	62.7	58.3	59.4
Bulk density kg/m^3	600	650	635

Numbers of turning for the pile = frequently turning through composting period.
Maximum C°/ day = the day which at it temperature reach its maximum.
Maximum C°/ day = the day which at it temperature reach its stability.
Moisture 1&2 = moisture content was recorded at beginning and end of composting period.
Final product =the final compost which produced form manure pile after stability with m^3

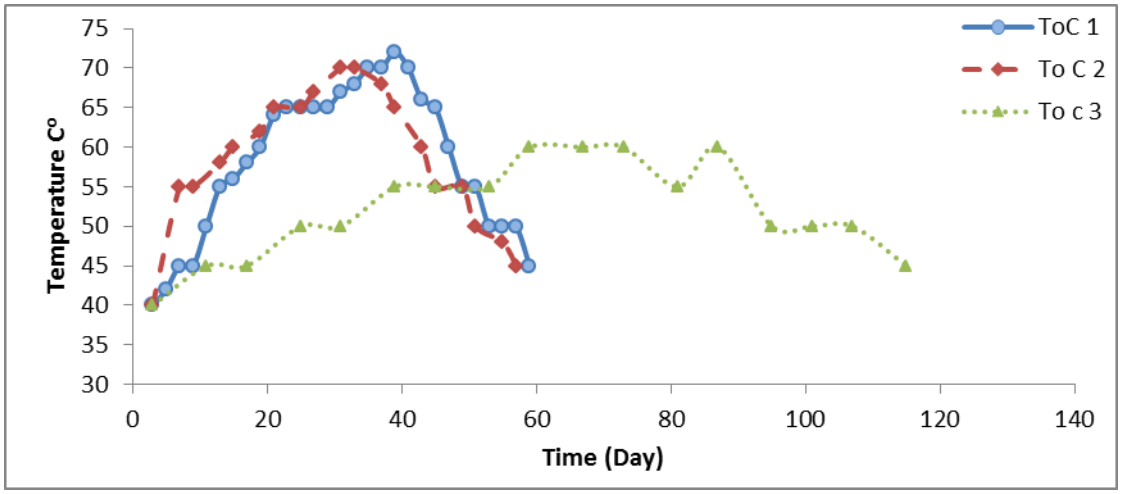

Figure (2) Recorded temperature for mix manure with rice straw pile

T° C 1 turning mixed pile three times per week
T° C2 turning mixed pile two times per week
T° C3 turning mixed pile one time per week

The bulk density was influenced by frequently turning and composting period however it was decreased with increasing the frequently turning and increasing the composting period.

Manure and press-mud mix.

Pile temperature and composting period, Table (3) and Fig. (3) Show that, the temperature was influenced by frequently turning however, at frequently turning three times per week the temperature was reaching its maximum 72° C at eleventh day after 19 times frequently turning and it was reach its stability 45°C at the day of 39. However, at the frequently turning two times per week the temperature was reached its maximum72° C at fifteen day after 15 times frequently turning and it was reach its stability 45°C at the day of 45. In the same context at the frequently turning one, time per week the temperature was reach its maximum70° C at seventeen days after10 times frequently turning and it was reach its stability 45°C at the day of 66 days (Bernhardt and Notcutt 1993). Mechanical turning at intervals of about four days provides sufficient aeration for aerobic decomposition and a six week composting period is required. The moisture also was influenced by frequently turning however; at frequently turning three times per week the moisture was recorded 35% at the end of the composting processes which stability. In the same time at frequently turning two times per week the moisture was recorded 38% at the end of the composting processes which stability. In the same time also at frequently, turning one time per week the moisture was recorded 30% at the end of the composting processes which stability.

Moisture content, was recorded the equal value for the manure and press-mud piles at the beginning the composting processes.

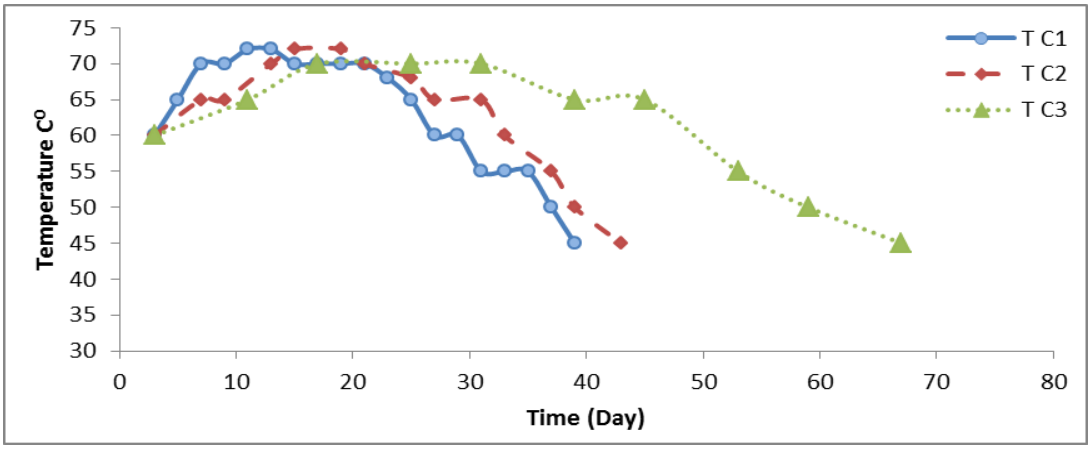

Figure (3) Recorded temperature for mix manure with press-mud pile

T° C 1 turning pile three times per week
T° C2 turning pile two times per week
T° C3 turning pile one time per week

Final production was 166.75, 163.3 and 161 m^3 from compost (manure and press-mud composted) for the frequently turning three, two and one time per week respectively. These cubic meters were given from 230 m^3 mixed manure and press-mud for all frequently turning.

Nevertheless, the reducing ratio was influenced by the time however; it was 27.5%, 29% and 30% foe frequently turning three, two and one time per week respectively. The residues, which output from sieves 1-inch decreases by the increasing of frequently turning however, at turning three, two and one time per week this residues was 6.9 , 8 and 11 m^3 from 166.75, 163.3 and 161 m^3 of composted piles with ratio 4.13% , 5 % and 7.14% respectively.

Table (3) shows numbers of pile turning for manure with press-mud pile and properties.

Factors	Frequently turning one time per week	Frequently turning two times per week	Frequently turning three times per week
Numbers of turning for pile	10 times	15times	19 times
Maximum ^oC/ day	70 C^o / 17 day	72 C^o / 15 day	72 C^o / 11day
Stability ^oC /day	45 C^o / 66 day	45 C^o / 45 day	45 C^o / 39 day
Moisture%1&2	(55 - 60) & 30	(55 - 60) & 38	(55 - 60) & 35
Final product m^3	161	163.3	166.75
Reducing ratio%	30	29	27.5
Final compost after screening on sieve 1inch m^3	149.5	155.25	159.85
Residual ratio%	7.14	5	4.13
Bulk density kg/m^3	610	720	670

Numbers of turning for the pile = the frequently turning for pile from beginning rising temperature and its stability.
Maximum C^o/ day =the day which at it temperature reached its maximum.
Maximum C^o/ day = the day which at it temperature reached its stability.
Moisture 1&2 = moisture content was recorded at beginning and end of composting period %.
Final product = final compost which produced form mixed manure with press-mud pile after stability with m^3.
Final compost after screening on sieve 1-inch = final compost which produced from the mixed manure with press-mud pile after stability with m^3.
Residual ratio = amount residual which output from the sieves 1-inch %.

This means that increasing of frequently turning affect positively on the fineness of compost this gives it more spongy structure and more porosity. Following shows the above and shows, that how much it is linked frequently turning with stability temperature.

Recommendation:

The best ways to recycling agricultural wastes is mixing it with manure and carried out turning on it two or three times per week and carried out on it the screening operation to obtain high quality and faster revenue. Press-mud can be recycling at short time with manure when add it at half period composting however the manure pile in this time the reducing ratio for it was reached to its maximum. So can be increasing production from final compost and enhancing its properties by mixed with manure.

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تاثير عدد مرات التقليب على بعض عمليات التكمير للمخلفات الزراعية

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أقيمت هذه الدراسة فى احد مصانع الكمبوست فى مدينة السادات - محافظة المنوفية عام 2011 واستهدفت دراسة تاثير عدد مرات التقليب على بعض عمليات التكمير للمخلفات الزراعية. لتحقيق ذلك تم جمع المخلفات قيد الدراسة و تجهيزها عبارة عن : المخلفات الحيوانية (الروث الحيوانى), المخلفات الحقلية (قش الارز), مخلفات التصنيع الزراعى (طينة صرف المرشحات لصناعة سكر القصب press-mud or filter-cake). ثم دراسة تاثير عملية التقليب الميكانيكى على هذه المخلفات و تاثيرها كذلك على : درجة حرارة الكومة (pile), المحتوى الرطوبى عند بداية الكمر وعند نهايتة , نسبة التناقص فى حجم الكومة خلال مدة الكمر, كمية المنتج النهائى وجودته, نوع المخلفات و مدة الكمر. وصممت التجارب كالاتى: الروث الحيوانى فقط و ابعاد الكومة 150 متر طول, 2.5 متر عرض, 1.2 متر ارتفاع. وكانت الرطوبة قبل الكمر مباشرة من 55 الى 60% وحجم الروث فى الكومة بعد عملية الكمر 230متر مكعب واجرى التقليب الميكانيكى عليها مرة, مرتان, وثلاث مرات فى الاسبوع. الروث الحيوانى مع قش الارز المدروس وابعاد المصفوفة 60متر طول, 2.5متر عرض, و اربع طبقات 40سم قش ارز,40سم روث,20سم قش ارز,20سم روث عل الترتيب ونسبة الرطوبة من 55 الى 60% وبحجم 180م^3 و اجرى عليها التقليب مرة , مرتان , وثلاث مرات فى الاسبوع. الروث الحيوانى مع طينة صرف المرشحات press-mud مع التقليب الميكانيكى مرة, مرتان, وثلاث مرات فى الاسبوع والكومة ذات ابعاد150 متر طول, 2.5 متر عرض, 1.2 متر ارتفاع والحجم بعد الكمر مباشرة من 230م^3. كان الكمر هوائى, ثم بدا التقليب الميكانيكى بواسطة ماكينة التقليب المجرورة خلف الجرار و التى تعمل بواسطة عمود الادارة الخلفى للجرار PTO من اليوم الثالث حيث بدات درجة الحرارة فى الارتفاع . من خلال النتائج لوحظ ان درجات الحرارة تصل الى ذروتها مع التقليب مرتان و ثلاث مرات فى الاسبوع فى الروث و المخاليط و اقصر فترة لمدة الكمر كانت مع التقليب ثلاث مرات فى الاسبوع للمعاملات الثلاثة الروث و المخاليط وتقل كمية المنتج النهائى بزيادة مدة الكمر و التقليب مرة واحدة فى الاسبوع وتقل نسبة التناقص فى الكومة بزيادة عدد مرات التقليب و قصر مدة الكمر و تقل نسبة الرطوبة بزيادة عدد مرات التقليب وزيادة مدة الكمر وتتاثر مدة الكمر بعدد مرات التقليب حيث تزيد مدة الكمر بتقليل عدد مرات التقليب. يوصى باجراء التقليب الميكانيكى للمخلفات الزراعية قيد الدراسة مرتان او ثلاث مرات فى الاسبوع و ذلك لتقصير مدة الكمرو زيادة معدل الانتاج من الكمبوست و ذو جوده عالية و تعظيم الاستفادة من المنتجات الزراعية.