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The Mushroom Journal

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The Mushroom Journal

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In the Editor's opinion . . .

Supply and Demand

'It seems that the mushroom trade is the one section of the salad trade, if not the entire vegetable trade, which is able to maintain reasonably stable prices for weeks on end. The supply and demand situation is such that most, if not all, of the salesmen are able to clear daily. This week, unfortunately, has seen the arrival of a few poor-quality sendings, and with the general market in such poor state, it is only the strength of the enquiry which manages to keep sales steady.'

The foregoing appeared in *The Fruit Trades' Journal* (18 March/77), and the reference to some poor-quality sendings apart, this is a statement which I for one never expected to see in my lifetime although I have always keenly supported any move to bring production in line with consumption.

It is of course absolutely true, that in the early part of the year mushroom prices returned on the open market in fact remained at a steady and satisfactory level — because of holidays I write this at the end of March and am well aware of how quickly the situation could have changed.

Growers will in no way be lulled into any sense of false security by present-day returns which are perhaps best described as being at a reasonably good level.

The past year or two has seen the industry in the doldrums, and sadly, there have been a number of casualties. For many growers it was a case, month in and month out, of struggling for survival. There were, I accept, one or two exceptions to this although, in those cases, the end-of-the-year profits were pretty dismal when compared with some previous years.

A look round many mushroom farms today shows the degree of neglect in the matter of straight maintenance and needed modernization, this type of expenditure being sacrificed to the need to simply keep afloat. Throughout, growers have been haunted, and still are, by the spectre of the shocking cost of repairs and replacement to existing buildings and machinery, knowing full well that the day will surely come when such expenditure must be met. Delays in carrying out day-to-day maintenance can be fatal.

Rejoice if you will at the breathing space allowed by a month or two of satisfactory returns, take a much-needed short holiday while the going is good, sparing a thought in the process for those other sections of horticulture where production has been at the mercy of the elements. In the end though, husband those financial resources garnered over the recent months; they will most surely be needed in future. Typical cost rises over the last four years are: tractor up 115%, gas-oil up 57%, petrol up 27%, electricity up 69% to name but a few. The recent budget made things even worse.

WRA

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Compiled by Dr. R. L. Edwards

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SRL = Science Reference Library.
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DENIS LOCKE TO BE MGA DIRECTOR

After five years with the Mushroom Growers' Association, Air Commodore John Bazalgette will be leaving the MGA in June. The new appointment, which has been made within the industry, goes to Denis Locke, Marketing Director to Country Kitchen Foods. Denis has been involved in food marketing for the last 23 years; formerly Sales Manager for Foster Clarke, he joined Country Kitchen, then known as Wrington Vale Nurseries, in 1962.

He is well known to many of the 180 grower members of the MGA and has served on Sub-Committees for Marketing and Publicity. His company was one of the six involved in the Midlands TV test campaign.

Having lived in the West Country for many years, his new appointment means a move nearer to London and he hopes to start taking up the reins of his new job early in May.

ERICA HAUSER

Before the Editor of *The Mushroom Journal* went on holiday last month he asked me to see this issue to press.

A few days later came the sad, sad news of the death on Easter Day of **Mrs. Erica Hauser,** head of the world-wide Hauser Organization.

Although she had been ill for more than a year, the departure of this resolute, tenacious, so generous lady came as a shock to us all.

An appropriate tribute will be published with details of her remarkable career.

Chairman Jim Gooding represented the Mushroom Growers' Association of Great Britain and Northern Ireland at the funeral in Gossau-Zürich on 15th April, in company with other friends and colleagues from the Mushroom Industry in this country.

FCA

INCREASED CONSUMPTION OF FRUIT AND VEGETABLES

Figures circulated by the Ministry of Agriculture show that preliminary estimates for food supplies moving into consumption in the UK in 1976 indicate a 6% rise to 3.9 kg per head for vegetables other than potatoes or potato products, which fell by 17%. Total consumption of fruit also increased by 6%.

1975–6 UK MUSHROOM PRODUCTION 117 MILLION LB.

The Ministry of Agriculture's estimated area, yield and production figures for fruit and vegetable crops for 1975–6 have recently been issued and the mushroom figures for the year ending June 1976 is an estimated 117,032,000 lb. or 53,196,000 kilos. The figures were issued in metric units and showed the area down to mushroom production as 374 hectares (897.6 acres, 4,344,384 sq. ft. or 421,784 sq. metres) producing 53.1 thousand tonnes of marketed mushrooms.

MGA Conference, Bournemouth, 1976

NEW DEVELOPMENTS IN THE MUSHROOM INDUSTRY IN HOLLAND

P. J. C. Vedder
Director: Centrum voor Champignonteelt-onderwijs, Horst, Holland

It is not so easy in Europe to have a profitable mushroom farm nowadays. For many years now the European mushroom industry has had to work under difficult circumstances. We need not go far to find out why. In many European countries the production of mushrooms has been on the increase for a long time. In the past ten years European production rose from 60,000 tons per year to more like 300,000 tons. Besides, the import of canned mushrooms from low-wage countries, especially Asian countries, has also increased, and lower returns are, of course, the result.

Production costs have also increased, especially as a result of the rapid increase in the cost of wages. Harvesting costs are greatly responsible for the increase. The average costs of harvesting form about 60% of the labour cost or 30% of the total cost. Another problem is the high cost of buildings, equipment, and energy for heating and cooling.

What we need to survive against ever-increasing competition is a highly mechanized growing method in more simple and relatively cheap buildings, e.g. in nissen huts or insulated plastic sheds. These simple buildings have been developed in the UK and a few Dutch growers have adopted this system. With such growing rooms, in combination with the other new developments, it is possible to lower the cost of investment and also the production costs.

In our opinion the best that a mushroom grower can do is to place racks for shelf-beds into these kinds of growing room. I know that mushroom growers have for many years been discussing the ideal growing system. There are firm believers in the multiple-zone system with spawning line and trays, whilst others feel more at home with growing in shelf-beds, according to the one-zone system.

Shelf Mechanization

In the past, one of the arguments against the one-zone system with permanent beds was that there is so little to mechanize. We need mechanization to lower the ever-rising labour costs. Mechanization has indeed, for many years, been almost entirely directed towards the tray system. There were only a few mechanical aids for sale for growing in beds. As time passed, however, this situation has changed. A special machine, for instance, has been developed for nearly every operation in the one-zone system. I won't refer now to the simple machinery for spawning, tamping, watering the beds, or the picking trolleys; most of you know about this equipment and we have used it for many years.

Tunnel Composting

I don't know if, in the future, we shall still speak about the one-zone system or shelf-bed system. With the developments in peak-heating in bulk and mycelium growth in mass or in tunnels, one can have a shelf-bed farm according to the multiple zone system.

The pasteurization of compost and the mycelium growth in bulk has been one of the most interesting developments of the last few years. This method, developed in Italy and France, was applied and brought to perfection in Holland too. After some research and practical experience, satisfactory results have now been obtained.

This so-called tunnel method is, in my opinion, much more rational than the more traditional

methods of peak-heating and mycelium growth in shelf-beds or trays. First of all because a lot of compost can be peak-heated and because spawn-running can take place in relatively small and simple rooms.

Filling, emptying and spawning does not take much work and can be easily mechanized with rather simple machinery like a front-loader and conveyor belts. Compost treatment in bulk requires little energy for heating (some more for the fans) and the different processes are easy to control and manage. During peak-heating in bulk, the required air (oxygen) can be brought where necessary, namely, into the layer of compost. With the traditional peak-heating method, the exchange of metabolic products and the supply of oxygen takes place by means of diffusion. Rather greater differences between the inside and outside of the layer of compost may then be expected.

With peak-heating in bulk, the differences in temperature between compost and air will be considerably smaller. In a well-equipped bulk room, these differences need not be more than 2 or 3°C.

During the traditional peak-heating process, the difference between compost and air temperature may even be 10 to 20°C. If we realize that the optimal range of temperature for the thermophile micro-flora, active during the peak-heating process in the compost, lies between 48 and 53°C., it must be possible to peak-heat compost in bulk more efficiently.

A great advantage is that only a little heat has to be supplied because the compost has the tendency to heat up of its own accord. The compost need not satisfy special standards; a compost good for normal peak-heating in beds or trays is also good for mass-pasteurization.

Apart from the considerably lower wear to which buildings, beds, trays and equipment will be subjected, another advantage of compost treatment in bulk is the more intensive use of growing rooms. Not only because peak-heating and spawn-running can take place in a different room, but especially because the beds or trays can now be filled to optimum capacity with, for instance, 90 to 100 kg. of fully-grown compost per m².

Tunnel Construction

The dimensions for a tunnel to be used for the mass treatment of compost depends on the quantity to be filled. If, for instance, fifty tons of fully-grown compost per week are needed, at least three tunnels should be built, one for peak-heating and two for spawn-running. (In our opinion it is better to have four rooms, that is to say two for peak-heating, while good peak-heating with the Dutch compost sometimes needs more than six days.)

Because, during peak-heating, about 25% of the compost is 'lost' and about 7% during spawn-running (loss of moisture and dry matter), the tunnel must, before peak-heating, be filled with about 75–80 tons of compost. In a layer of approx. 1.80 to 2.00 m., one ton of compost needs a floor area of about 1.1–1.2 m². A dimension of 5 × 18 m. or 4 × 22 m., and a height of about 3½ m. above the grid floor, could be envisaged. When the layers are deeper, the compost, especially the lower part, may be sagging too closely. Aeration will then become more and more difficult and the result will mean greater differences in temperature, local lack of oxygen, less good compost, a longer peak-heating process, etc.

The floor of the bulk room is a double one. The lower floor of insulated concrete lies about half a metre below normal floor level. The second floor consists of wooden beams with openings between or concrete grids.

All the openings together should cover about 25% of the floor surface. Under the floor sufficient air circulation is necessary; the free space between the two floors should therefore be at least 50 cm. For a good pressure distribution and a restriction of the air velocity, it would be desirable for the floor to slope down at least 2% to the air inlet. At that lower point, provisions are made to carry off the leaking and the condensed water (a few thousand litres) and the water needed to wash down the room. This provision for water discharge must be airtight or be lockable.

The walls of a bulk room must of course be well insulated to a K-value of, e.g. 0.5. In practice, these walls are often made of foam concrete, e.g. Ytong or Siporex blocks, 20 cm. thick. Aluminium sandwich panels filled with polyurethane material can also be used. The lower part of the wall, however, should be protected against any damage, for instance, damage done by the tractor with fore-loader.

On the inside the walls should be finished —

vapour tight — with a bitumen product, for instance with Flintkote, to prevent moisture from penetrating into the wall. The roof can be covered with Eternite sheets or sandwich panels. These sheets should also be finished vapour-tight. For the essential heat insulation a layer of 25–30 cm. thick rock-wool should be put on the ceiling.

One or both of the short sides of the bulk room should have double doors which must close hermetically and should be well insulated. A second wooden wall can be made behind the doors to prevent the compost from pressing against them.

It is normal and also most logical, for the air to be blown inside at the bottom of the room and under the compost, and that it is then exhausted at the top of the room.

Temperature, Air and Ventilation

To get the desired even temperature, the ventilator for the air circulation should have a capacity of at least 150 m^3 per ton of compost per hour; it seems better to have 200 m^3. The static pressure should be about 100 mm. w.g. A centrifugal high-pressure fan should therefore be chosen.

The necessary pressure of course varies with the depth of the layer and even more with the structure and the moisture content of the compost. We are convinced that the poor results with peak-heating and mycelium-growth in tunnels in the early days were for the most part caused by having a fan with not enough capacity.

By far the greater part of the air is the circulating air being exhausted in the space above the compost and blown inside under the grid floor. Only a small proportion of the fresh air, for instance 5% to 10%, is drawn inside. This fresh air is used for oxygen supply and temperature regulation during the peak-heating process and spawn-running. The fresh air, drawn in, should of course be filtered.

In view of the desired CO_2 concentration, it is important that the entire space, including the ventilation ducts etc., should be thoroughly airtight. It is obvious that there should be a lockable opening in the top of the room to carry off exhaust air.

For peak-heating in bulk, just as for mycelium-growth in mass, it is usually hardly necessary to add heat; both processes are taking place almost of their own accord.

To accelerate the peak-heating process, after filling some live steam can be injected into the air stream under the floor. The moisture content of the air and, as a result, that of the compost, can be reasonably regulated with steam.

It was found, under normal circumstances, that after peak-heating and during spawn-running, extra cooling is unnecessary. Greater supplies of fresh air may give sufficient cooling in a rather short time. The temperature should, of course, be duly regulated automatically by means of feelers in compost and air, and by the mechanical operation of the steam inlet and the fresh-air valve.

We think the best and easiest way of filling a bulk room is with a set of conveyor belts, the last part slanting and provided with a swivel. Outside the room, a tray or box of measured capacity can be placed on the belts, bringing the compost on to the belt in even quantities. The compost is fed into the special tray or box with a front-loader. It is important that the bulk room should be lightly filled, in even quantities.

Divided over the room, the measuring points of the distant-reading thermometer are placed in the compost and in the air. After filling, the room is closed, the fan switched on and the steam let in to heat the room and compost to the required temperature to accelerate the process. When the compost and the air temperature has risen to about 58–60°C., efforts are made to maintain this situation for at least five to six hours. During pasteurization, the temperature of the compost should, of course, be controlled in several places, especially along the walls and just above the grid floor.

With sufficient circulation, the differences in temperature in a well-constructed room will be minimal, both in the compost and in the air. To keep the desired thermophilic micro-flora in the most active state possible, it would be desirable to let in a constant and small supply of fresh air, even during pasteurization. For the same reason, temperatures above 60°C. should be avoided.

After pasteurization, to kill all the harmful organisms, the temperature in the compost, in eight to twelve hours and step by step, is slowly brought down to the optimal level for the conditioning phase. It was found that the optimal temperature range for the thermophilic flora, active during conditioning, moves between 48 and 53°C. The supply of fresh air is

therefore regulated in such a way that the desired temperature can be maintained, while a CO_2 concentration of 1 to 2% seems desirable.

After six to eight days, when the compost is free from ammonia, it is, with a lot of fresh air, cooled down as soon as possible to the spawning temperature of about 25°C. Then the compost is taken out of the room with a front-loader and put into a similar room next to it in a layer of about 1.50 m. To fill the bulk room with peak-heated compost for mycelium growth we use the same dosaging machine with conveyor belts and a front-loader. At the same time, 6 to 7 litres spawn per ton of compost is mixed through. In practice, spawn-running in mass gives very few problems, provided the room is well-equipped from a technical point of view and is sufficiently airtight.

The optimal temperature for spawn-running, about 25°C., is also regulated by the small quantity of fresh air admitted. The circulation is then constantly kept at full capacity. All the air supplied should be duly filtered.

When, after twelve or thirteen days, the compost is fully-grown, the material can be put into trays or beds and be cased immediately.

Of course, every care should be taken to avoid infection during the transport of the compost from room to room, after peak-heating, as well as after mycelium growth from the bulk room into the beds or trays. We have really good experience with peak-heating and mycelium growth in mass, in drs. Gerrits's research as well as in practice.

As you know, we in Holland like to do as much as possible on a co-operative basis. For that reason it is understandable that at the co-operative composting enterprise at Ottersum and also at another private composting enterprise, there are now also a number of big tunnels under construction. So, after a few months, the Dutch growers can buy their fully-grown compost.

Synthetic Fibre Shelves

A still young, but highly interesting development in the shelf-bed system in this connection, is the use of synthetic fibre nets for filling and emptying the growing rooms.

In co-operation with the Growers' Association the Thilot firm has developed a machine to fill the beds with a layer of pressed, peak-heated or even fully-grown compost.

The basic point of this filling machine is that, if a layer of compost can be pulled outwards over a length of 20 m. for instance, the reverse must also be possible. The machine used to fill the beds provided with nylon pulling nets on the bottom, consists of a box-feed apparatus which is placed before the head end of the beds. The compost is dumped into the box measure with a tractor front-loader. With this feed apparatus, a packed layer of compost of even thickness is placed on the nylon cloth. The net with the layer of compost upon it, is simultaneously and slowly pulled into the beds with a simple roller.

The floor of the beds need not necessarily be boarded. For some time, tiers have been erected; the net in those tiers lies on a metal grid. The absence of wood is even an advantage considering the possibility of infestation by pests which may have survived in the wood, for instance, eelworms, moulds, and virus diseases which may effect spawn-running.

If the growing rooms are filled with fully-grown compost, for instance, from a bulk room (tunnel) on the farm, or supplied from a central place, we shall have of course to pay the necessary attention to the inevitable provisions to avoid infections. In this respect we are thinking of filling from a closed container or press-packets, sealed in plastic foil.

It is understandable that emptying after a crop is quite simple; for this purpose we already have used the nylon nets for a couple of years.

After the process of growing, the nylon net is wound on a roller on one of the short sides of the bed, which is emptied in this way. The compost falls off on to a conveyor which takes the compost to a truck or into a container. Emptying a room of about 200 m^2 by pulling in this way takes about 90 minutes.

After pulling the net away the beds are surprisingly clean and only a little handwork remains. Up to a length of 20 m., pulling does not seem to present any problem, provided the floor of the bed is even and has no projecting parts.

The firm of Thilot at Lottum and recently the firm of Keysers at Horst have made a compact construction for emptying, easy to operate and a combination of the different components, such as the roller to wind the net and the short conveyor belt. A number of these machines have been used for many years by the emptying

department of the Co-operative Mushroom Growers' Association; they clean the growing rooms for the members and collect the spent compost in containers.

Harvesting

Because the cost of harvesting forms such an important part of the cost of production, investigations about harvest mechanization have already been made for many years and in many places.

Farms where multiple zone systems with trays are applied, are trying to get on by improving their working conditions. They transport the trays or beds with fully-grown mushrooms on so-called picking lines. The harvesting itself is still done by hand. But, so far, these systems have not yet been generally accepted. There could be no saving of labour because of the adaptation problems and other difficulties. Besides, it costs a lot of energy to move the trays and these trays need high investment and the system can only be used on large farms.

The Dutch mushroom growers are also trying hard to find a solution to keep the increasing costs of harvesting within certain limits. Picking trolleys were, for instance, developed in order to facilitate harvesting and to give better results.

On different farms, the harvesting of more coarse mushrooms (off-white strains) has already become important. By growing highly productive strains and adding 1 kg. of soya-bean meal (SACing) per m^2 just before casing of the beds, various farms have produced high yields.

Flushes of 10 to 12 kg. of trimmed mushrooms per m^2 are no exception. At present we leave the fruitbodies on the beds to grow to a maximal size so that there is no longer any question of first quality, in other words, of buttons.

Some mushroom growers in Holland, together with a constructional company and the Horticultural Engineering Institute have for some time been experimenting with a quite useful harvesting machine.

They gathered that it should be possible to cut the mushrooms of a heavy flush from the beds in one operation. The fact that nearly all the mushrooms in the Netherlands are grown on relatively long and uniform beds proved a great advantage.

If we want to use such a harvesting machine, there are a few conditions which should first be fulfilled.

Need for Even Flushing

The beds must be completely even because the machines will be moving on them. New kinds of tiers have meanwhile been developed, however, in which no wood is used and in which special profiles have been made on either side. On these profiles the different machines for levelling, roughing up and cutting move. The surface of the beds should be perfectly smooth. To achieve this, we have to be careful when filling the beds with compost, both during filling and tamping. We think the new filling system for fully-grown compost makes this much easier.

Casing, too, needs special care. Above all, the upper layer of the casing should run quite parallel with the side-boards of the bed. A simple machine was therefore constructed to level the surface of the beds after the application of the casing layer. This machine, with low gears, moves over the edges of the bed.

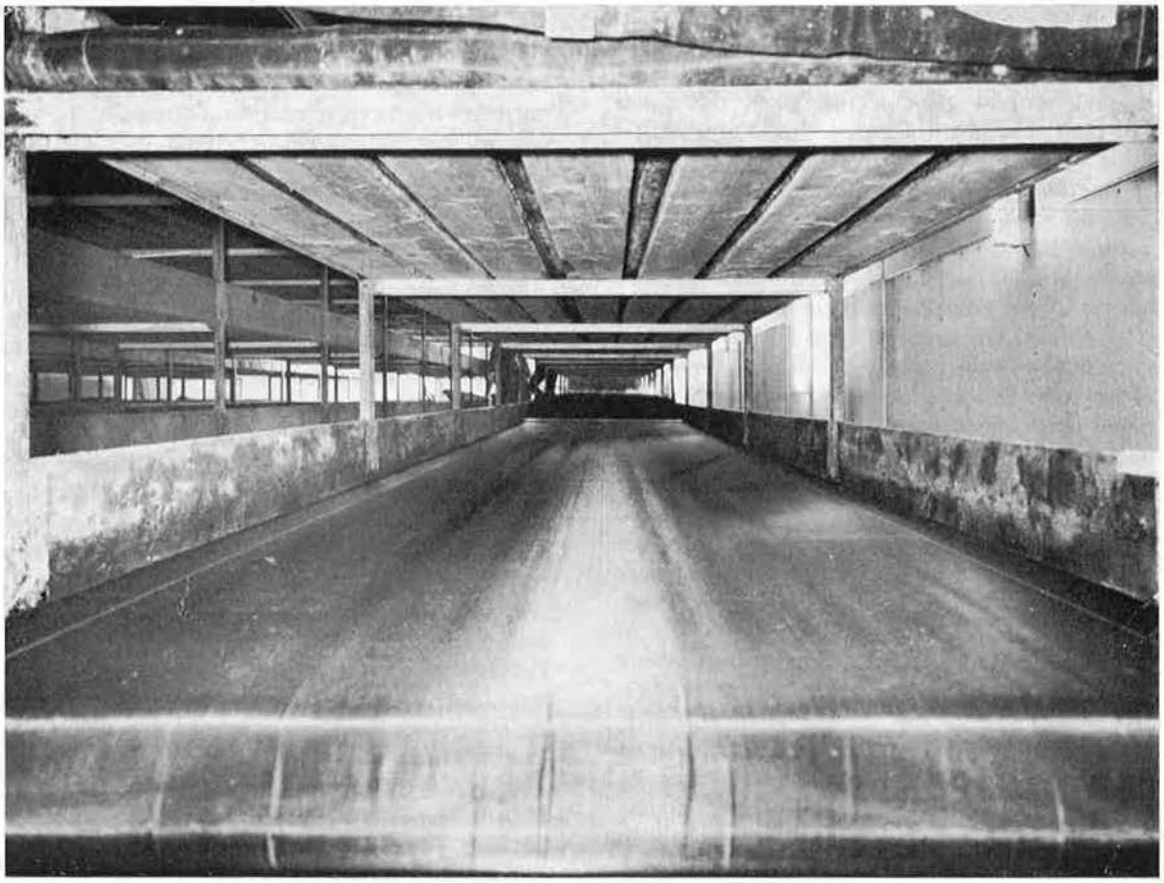
It is also of great importance that the flushes should come evenly and regularly, and cover at least 8 to 10 kg./m^2. For this purpose, off-white strains will then be useful. Immediately before casing, the fully-grown beds can be supplemented with soya-bean meal.

About six or seven days after casing, the casing layer is roughed up rather deeply to get a very regular and sufficiently large first flush. The casing layer, which mostly slightly thickens after repeated watering, is roughed up down to the compost layer. The mycelium, which until that time has already penetrated the casing soil for about three quarters, has, with this treatment, been thoroughly mixed through the casing soil and has, of course, been partly damaged.

A simple machine to scratch the casing soil has already been constructed. This is composed of an electrically-driven shaft with teeth, mixing the casing soil and slightly tamping it again with a mobile roller, so as to make sure that the upper surface is perfectly level.

After about one day, the mycelium has recovered and a few days later it has almost reached the same height both in and on the upper surface of the casing soil in the whole room.

As I have already said, we leave the flush of mushrooms on the beds to grow until they have



A striking picture of a shelf-bed being filled with the aid of the synthetic fibre belt mechanization system

reached the maximum size. Then they are cut in one operation. Cutting will only be successful when the beds are completely full and the mushrooms are standing close together. If not, the knife will press the mushrooms forward and may cut them through lengthwise.

Before starting harvesting mechanically, a small section along the side-boards, upon which a small gear of the machine moves, must be harvested by hand, or it should be covered before casing with a small strip of plastic foil.

Cutting Machine

The harvesting machine consists of a moveable knife which, in a framework with small gears, passes over the side-boards of the bed. The machine has now gone through most teething problems and is already used on some farms. There is one type of machine which works with a cross belt, removing the mushrooms on either side of the bed. There is another type which deposits the cut mushrooms on a nylon cloth.

When the cutting machine has reached the end, the nylon cloth is wound on to a roller while the mushrooms are collected in a case at the head end of the beds. The useful capacity of the machine is very high. Cutting beds, for instance, 15 m. long and about 1.40 m. wide (about 20 m^2) only takes a few minutes.

A growing room with shelf beds, covering a surface area of about 180 m^2, can be harvested with three men in about four hours, including extra work. In that case about 1500 to 2000 kg. of mushrooms of second or third grade (opens and flats) are involved.

What About Stalks and Stumps?

So far, the great problem has always been concerned with what happens when the mushroom stalks and stumps are left behind on the

beds after the mushrooms have been cut. In practice, this seems to be dealt with better than could be expected. The stumps dry almost completely, and after a few days the small fruit-bodies of the following flush appear. To avoid green mould, such as *Trichoderma* etc., the humidity between the flushes should not be kept too high.

When we leave the mushrooms to grow to maximum size, the flushes do not come with an interval of one week but with an interval of eight to nine days. On average three flushes were cut in about four weeks. The yields in that time were mostly from 18 to 22 kg. per square metre.

After two or three of these big flushes, few mushrooms will grow on the beds. The risk of disease will greatly increase during the last growing weeks. On farms where mechanical harvesting is to be introduced, the growing plan should be adapted to the new working method.

It is quite clear, that with this new development, we can greatly economize on the cost of harvesting. But a lot still needs to be done before this working method can successfully be used on other farms. We do not yet know, for instance, what diseases will result from continuous cutting. We know, however, by experience, that by growing open mushrooms almost exclusively, there is considerable risk that virus may result from this development. For the present it still seems very difficult to harvest mechanically a good product for the fresh market. It is still open to discussion whether, over a long period, the growth of quality products could not be more profitable, even if the yields were lower and the costs of harvesting higher.

We know that the ideal growing system does not exist. Considering the developments, however, we are of the opinion that we are already well on the right track. At any rate, no one can now say, as in the past, that there is nothing to mechanize in the shelf-bed system.

CONVERSION RATE

The true conversion rate for a 3 lb. chip of mushrooms is 1.361 kilos and not 1.362 as reported in connection with the Bournemouth conference proceedings.

PUBLICITY FOR MUSHROOMS ON THE MOVE

Now that the MGA's income for publicity purposes has been placed on a secure basis, and in a full year is expected to bring in over £50,000, plans for increased mushroom publicity have already been approved by the Publicity and Marketing Committee and will embrace all stages of distribution, from grower to consumer.

Immediate efforts are being made to use up all stocks of the old point-of-sale material and the new posters etc., already approved, will include the new mushroom character which, the committee has agreed, is to replace 'Monty Mushroom'.

One of the corner-stones of mushroom publicity has been the accepted need to get together cookery journalists who, throughout the range of publications have been responsible for so much mushroom publicity, and by way of a deserved 'Thank you', such writers are to be entertained with a trip to Bristol and a special luncheon at Thornbury Castle, one of the top UK restaurants. The trip is planned for May and there will be a well-known personality delivering an after-lunch talk.

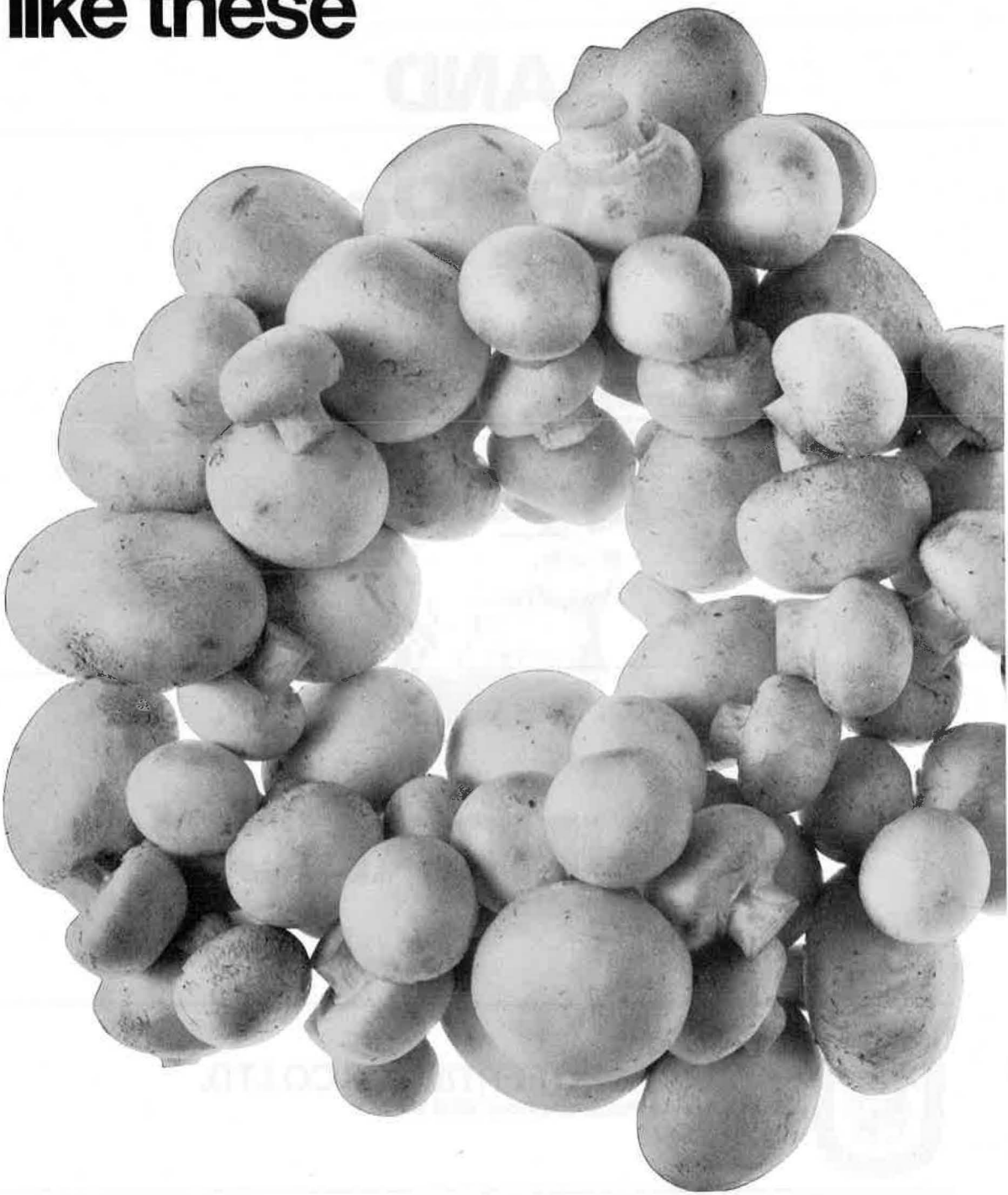
A special colour booklet, as an insert in *Good Housekeeping*, will be distributed with the October issue of that publication and has an assured and immediate circulation of 310,000. An additional 200,000 follow-on copies will be made available afterwards. Additionally, a new paper-back recipe book, prepared by the MGA's Publicity Officer, Valerie March, is also to be published.

The usual day-to-day publicity activities continue unabated covering close liaison with the Electricity Board and Gas Council nationwide, stores large and small, exhibitions and schools, and special mushroom displays at various county agricultural shows have already been planned.

At the Royal Bath and West Show, for instance, the MGA will be combining with the GCRI and the Ministry of Agriculture, to put on a special display (31st May–4th June) and a similar effort will be made in connection with the Royal Show at Stoneleigh (4th–7th July).

The regular use of the MGA's own promotional films and the level of the number of Press clippings which the MGA office regularly receive, are indications of the continued success of these publicity efforts.

if you want mushrooms like these



you want spawn like this

developed according to the Sinden Process
tested
proven
hygienic
reliable
delivered by refrigerated truck to your door

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Fred. C. Atkins *writes about:*

NIPPONESE TRANSACTIONS — NEWS OF JIMMY GAHM

Mushroom Science IX (Part 1: Japan) arrived on my desk early in March. It weighs 3¾ lb. (1.70 kg.) and by surface mail the stamps amounted to 1200 yen or £2.50. It costs about £40 inclusive of postage and packing — unless you ordered your copy before 5th October last, when the pre-publication price was £35.

A stupendous sum, yes; but absolutely essential reading for anyone working seriously in this field. And it has been impeccably printed by the Japan Science Press in Tokyo — probably the most expensive city in one of the most expensive countries in the world. It is very similar in format, paper, presentation, type faces and binding to Maney's *Mushroom Science* VIII, which is real praise.

The number of pages is almost identical, too. There are 81 papers, 67 of them in English and 36 relating to *Agaricus* spp. I have always been disinclined to introduce other cultivated fungi into our narrow *A. bisporus* field, but I now concede that I was a fuddy-duddy in that attitude.

It is too late for me to start growing them, but I am fascinated by the papers on *Lentinus*, *Pleurotus*, *Volvariella* and *Tricholoma* spp., as well of course as *A. bitorquis* which is now being grown all-year-round by some Dutchmen.

Man in a red blazer

Still in the forefront in 1974 was *l'éminence rouge*, the Mushroom Cardinal himself. Dear old **Pieter Bels** in his opening address in Tokyo described the First Congress in Peterborough in 1950 as 'an eye-opener to growers'. It was certainly an eye-opener for the researchers. The Dutch Inspectorate of Horticultural Research suggested 'a conference between investigators and growers in various countries' and, unless the autocratic memory is failing, Pieter will agree that it was the acceptance of the idea by the MGA which made it possible. I do not regard it as heretical to say that growers are as important as investigators in the Mushroom World; but then I do not like being regimented.

Ron Edwards 'reviewed the manuscripts for publication'. Yet I am referred to as F. C. Atvine on page 317, in a paper on the control of *Mycogone* by **Tsu-Chang Dough**, who knew my real name in 1971, according to the *Journal of Taiwan Agricultural Research*. After being addressed as Mr. Thistlethwaite and then G. F. Atkins, Atvine is too much. It's a conspiracy!

Publication delays

The Japanese transactions were published more than two years after the Congress. The Taiwan papers should have appeared by now.

Mushroom Science IX (Part 2: Taiwan) will in fact be published this month at a cost of about £6.00 plus postage. Application for copies should be made to The Chinese Society for Horticultural Science, P.O. Box No. 13-103, Taipei, Republic of China.

The French are determined to be less dilatory; **Jacques Delmas** is an impatient man who gets things done. He makes his point loud and clear in the First Circular about the Tenth Congress in France (5th–15th June 1978 — just one year ahead!):

'An absolute requirement for publication of the accepted papers will be the remittance of the full paper ready for publication one month previous to the opening date of the Congress. This is a decision taken by the Scientific Program Committee in order that *Mushroom Science* X may be available within six months after the Congress date'.

Bravo! And what an irresistible programme!

Frosts in Florida

How is **Jimmy Gahm**, I asked last December (*Mushroom Journal*, **48**, 1976)? To my delight I have had news of him. **Geoff Emden** tells me:

'He is living at Fort Myers in Florida. At the end of his last letter (January 1977) he is complaining of the odd weather there, with many schools closed through shortage of fuel oil, gas and electricity. There had been a heavy frost in Fort Myers, a most unusual event apparently. He mentioned that he had been up to his old farm in Canada in August and found that the ten acres now consisted of high-rise apartments.'

Who said this?

Up to two litres of Diesel Oil per ton was added to compost without affecting either the cropping or the appearance of the mushrooms.

Fred. C. Atkins: Meditating on Mushroom Composts

I offer no excuse for returning to this subject of compost — the heart of the mushroom business — but I do apologize for my lay approach. When one writes as much as I do one needs meditation — and I have reached the stage and age when at last I realize the awful extent of my ignorance. If you disbelieve me, read on.

Have you read John Abercrombie's textbook on mushroom growing? Written just 200 years ago it tells us to 'use the best, fresh, horse-stable dung and litter, warm and moist, rejecting such as is dry and decayed'.

Sound advice. The essential word is *fresh*. Make this quite clear to your agents or dealers. If they send you manure which is grey and tired, or cold and sodden, refuse it. Ask them whether they really want your business . . . But first decide what to do if they should say No!

Fresh droppings are a useful indicator. A horsey smell means the animals have actually been in the stables. Remember that equally good crops of mushrooms can be obtained from straw containing much urine even when few droppings are visible. But you know all about that. Let us get a little more technical.

Compost Constituents

What do we need? Hayes has usefully summarized the situation:

Nitrogen: There is a specific protein requirement. Nitrogen provided to activate the fermentation is converted into microbial protein — the 'biomass' of thermophilic micro-organisms and their by-products probably provides the required protein.

Carbon: This primary energy source is provided largely in the straw as cellulose, hemicellulose and lignin, which are broken down to simpler carbohydrates, firstly by micro-organisms during fermentation, then by enzymes secreted by mushroom mycelium, and finally by micro-organisms active during cropping.

Minerals: Calcium, phosphorus, potassium and other essential minerals and trace metals are provided in the straw, manure and activators. When composting mixtures are correctly formulated these are in adequate supply but may be deficient in some synthetic mixtures.

Vitamins: These growth factors are synthesized by micro-organisms during composting.

Acetate: These 'building blocks' are likely to be continually synthesized by latent microbial activity.

Nitrogen

At the start of composting the nitrogen content should be at least 1.5% of the dry matter. As the nitrogen in horse manure today is consistently below this level, sometimes as low as 1.0%, we need to supplement.

Bovenkerk told us in 1958: 'Some years ago we used to get manure with 1.35% N but now it is much closer to 1.10%. Manure containing 1.10% N produced 1.6 lb./sq. ft. but when supplemented or "boosted" did 2.1 lb.

'Manure with 1.35% N gave 2.0 lb./sq. ft. and, supplemented, nearly 3.0 lb.

'Nitrogen is a good index of potential yield because when N is present the other organic materials required are usually present'.

His final deduction is no longer valid. Hayes and others have emphasised the significance of the Carbon/Nitrogen ratio, and it is contended nowadays that higher levels of nitrogen require more carbohydrate.

You recall that work by Smith and Hayes indicates that ratios outside the optimal range of 17:1 at spawning can cause substantial reductions in yield.

Cottonseed meal is an admirable source of readily-available carbohydrate as well as organic nitrogen. As Barnard once said to me: 'The amino-acid and vitamin content is exceptionally comprehensive'.

One of the most popular nitrogenous supplements is chicken manure. Gerrits put it in these words: 'The advantage of chicken manure and other organic materials like cottonseed meal as compost additives is that nitrogen is added without the danger of quickly disturbing the C/N ratio, because carbohydrates are added as well'.

But not everyone would agree that the carbohydrate fraction in chicken manure is available as readily as it is in cottonseed meal and, perhaps because of this, one can easily overdo supplementation with chicken manure, with greasy consequences.

Gypsum

Is this why Gerrits stresses that 'the addition of gypsum is of tremendous importance, especially if larger amounts of chicken manure are used'? By 'larger amounts' he means more than a tonne of chicken manure per tonne of straw in his synthetic compost, or more than 10% in an average sample of horse manure.

In my *Guide to Mushroom Growing* I say: 'Theoretically, the earlier (the gypsum is added) the better will be the aeration of the stack; but there is a fear that gypsum interferes with ammonification and in so doing militates against the essential softening of the straw; this is why gypsum is more usually given not sooner than the second turn'. Today I would be more dogmatic and stipulate *not later than the second turn* — with more, later, if the compost is a little wet or greasy.

Pizer has always urged us to add our gypsum as early as possible in Phase One, and Stoller, if I interpret him correctly, agrees; he has always deplored our wanton waste of ammonia nitrogen, and early addition tends to conserve it.

Straw

But Pizer was writing in 1936 and Stoller in 1954, and I doubt whether either had encountered the problems presented to mushroom growers by Capelle and similar straws about which I wrote in 1957: 'Last year, when we received a load of really tough straw, pithy inside, the result was a crop half our average. What can we do? The new strains of wheat are almost certain to have tougher-than-ever straw'.

We found we had to pre-wet before making-up on Day O, a practice some have been known to deprecate! By far the most effective way of adding water evenly to loads of horse manure or supplemented straw is to pass them once or twice through a turning machine.

If the resulting stack is wide enough and sufficiently compacted, ammonia will be evolved to feed the voracious bacteria, the required heat will be generated and the straw will quickly soften and then be able to absorb all the water you care to give it — as growers who have neglected to build a roof over their composting areas will concede.

When they complain about 'too many yellow straws at filling', consultants are merely pointing out that some of the carbohydrate has not been made available. Be patient — it soon will be. Just as a few Ink Caps do not mean the end of the world; you may indeed reap an unexpected benefit because some have the ability to convert residual ammonia into acceptable protein, as Sinden has explained.

Phosphorus

What about the NPK ratio? Since phosphorus appears largely in the horse droppings and scarcely at all in the urine, would we be safe in deducing that phosphorus is of little value to the mushroom? In their synthetic-compost formulae Stoller (1943) recommended 2.8 kg. per 50 kg. of nitrogen, the MRA (1949) 5.9 kg. and Lambert (1941) 15 kg., while Sinden (1946) added none. These figures are calculated from data provided in *Mushroom Science 1* by Edwards.

For horse manure deficient in droppings, i.e. very light racing-stable manure in summer, perhaps we should adopt the practice which is, or used to be, followed by some growers in the United States and add a little superphosphate before going into peak heat.

Pizer (1937) tells us that 'many horse-manure composts are low in phosphate, and the addition of a little superphosphate will usually stimulate mycelial growth appreciably'. But then he inserts a question I have been asking ever since: 'Does rate of (spawn) penetration into the compost

affect cropping?' In theory it should: colonization in advance of competitors is generally considered beneficial.

The results of the MRA trials with phosphate in synthetic composts are interesting. Edwards reported in 1949 that 'no benefit whatever was obtained by putting in superphosphate when the stack was first made, but when added at the fourth turn it gave a substantial increase in the number of mushrooms and in the total yield.

'This was not merely a stimulating effect on fruiting because it persisted throughout the cropping period and was not accompanied by any fall in size of the mushrooms as one expects from a substance acting purely as a fruiting stimulant.'

On the other hand, our Ministry of Agriculture *Bulletin 34* (1938 edition) says: 'When a supply of manure is known to be good, phosphate is unnecessary . . . and there is evidence that it may then shorten the cropping period and lower the yield'. But with poor manure it would be 'well worth a trial'.

Another attraction of chicken manure as a supplement is that the phosphorus fraction almost certainly dispenses with the need for adding superphosphate. Pennsylvania State College's *Bulletin 469P* (1944) publishes this relevant table:

Horse manure:		
0.70% N	0.25% P_2O_5	0.55% K_2O
Hen manure:		
1.48% N	0.96% P_2O_5	0.47% K_2O

However, if we are supplementing a light manure deficient in droppings, or indeed a synthetic compost, with an activator which contains no phosphorus, trials with *not more than* 7 lb. of superphosphate per ton of compost would seem sensible. Mixing it with 21 lb. of gypsum would certainly facilitate uniformity of distribution and reduce the risk of high-level pockets.

Potash

Potassium is a different matter. It is excreted largely in the horse's urine and scarcely at all in the droppings. Pizer postulates that one cause of greasiness is an excess of potassium over calcium; but the universal addition of gypsum takes care of that hazard.

Has it a vital role in mushroom composts? I have referred already to the table Edwards published in 1950. Adapting it again to 50 kg. of N in synthetic-compost formulae I find that Stoller and the MRA recommended 9.7 kg. of K, while Sinden suggested 35–75 kg. and Lambert none at all.

In his work on synthetic composts Stoller remarked: 'By employing spent liquorice roots and brewers' grains, *materials from which the K had been extracted*, it was possible to demonstrate an increase of 133% in yield by adding K'. He added that Sinden had confirmed his findings.

Good horse manure probably has an adequacy, and yet another virtue of chicken manure in synthetic composts is that it contains almost the same amount of potassium as is found in horse manure.

Incidentally, the dark-brown liquid which sometimes drains away from a manure heap is rich in fertilizer substances, particularly potash. So keep run-off to a minimum.

I much like the concept of supplementing the compost at the end of Phase One with lipids or protein, which Hughes, Schisler and Sinden pioneered, and the prospect of delayed-release nutrients. But I have little first-hand experience in these fields and none with Promysarb or Spawn Mate.

While I await criticisms from those who know more about organic chemistry than I do — which means almost everybody — I want to dwell for a moment on the physical aspects of composting; they are very important.

Physical Aspects

We all know how much easier Phase One is if we start with a more-or-less homogeneous material. No time spent in blending the various loads of horse manure is time wasted.

So we come to make-up — Day 0 in Sinden parlance. As Lambert put it in 1941: 'The physical conditions (temperature, moisture, and aeration) are dependent largely upon the size, shape and compactness of the heap'.

American growers 30 years ago frequently made their heaps 20 ft. wide and about 4 ft. high, after the French pattern. Lambert was able to demonstrate that this profile causes extensive stratification.

The outside layer varies in temperature from that of the surrounding air to 110° F. The layer immediately below and behind may be 110 or 140°. Further into the stack, resembling two large cylinders within 2 to 4 ft. of the sides and 1 to 3 ft. from the top of the heap, are hot areas from 150 to 180°. The temperatures in the entire lower centre of the heap languish between 100 and 130°, and conditions there can soon become acid and anaerobic.

Lambert went on to demonstrate that by reducing the width of the stack to about 6 ft. one could avoid anaerobiosis and at the same time provide optimal temperatures of 150–180° in more than half the stack instead of perhaps only one-tenth of it. It was a remarkable advance in applied technology.

Sinden was working along similar lines, and with Mrs. Hauser in 1950 presented a paper which advised us 'to keep the pile small enough in cross-section to prevent a sour-smelling, anaerobic core from developing. If the manure is long and strawy and the composting is being done in the winter with a good temperature differential between inside and out, the pile may be 8 ft. wide by 5 or 6 ft. high; but if the manure is short and heavy the pile may have to be reduced in size to a width of 4 ft. and a height of 4½ ft.'.

Three years later this was qualified to read: 'While the shape of the pile is always rectangular, the size of it must be so large that any increase would result in an anaerobic core'. Yes, sir!

Turning Schedules

When I came into the Mushroom Industry 40 years ago we were giving rich horse manure four turns at weekly intervals. My memorandum on White Plaster Mould urged growers not to under-compost . . . .

Today, following on Sinden's heels, a common schedule is make-up on Day 0 and turns on Days 2, 4, 6 and 8 — perhaps 2, 4, 6, 8 and 10 in summer, when composting proceeds a little more slowly.

My original draft for this paper included a survey of Stoller's concrete mixer, Sarazin's pits, various barrel devices, composting *en masse*, Lambert's two-phase pasteurization and Sanford's system . . . but you know as much, or as little, as I do about them.

Let me leave you with Lambert's words of consolation written 36 years ago: 'When manure was composted under different combinations and sequences of conditions it tended to assume characteristics typical of the last environment to which it was subjected. Thus, aerobic fermentation at moderately high temperatures would again render compost suitable even though it had previously been made unsuitable by excessively high temperature fermentation or by anaerobic conditions'.

But if you rely too much on this philosophy it means you are making too many mistakes — and mistakes in today's economic climate can be disastrous.

NEW SPAWN PLANT?

A report in the *Ipswich Evening Star* (4 March/77) stated that a plan by Mill Farm Mushrooms Ltd., Eye, Suffolk, to establish a plant to breed 'new mushroom spoor' [*sic*] in four buildings in the grounds of Roydon Hall, near Diss, is being opposed in the village of Roydon.

The report quotes Mr. J. C. Hopper as saying that Mill Farm Mushrooms employs twenty-four people at its mushroom farm situated on the former airfield at Eye and would take on twelve more workers and raise production by 30% if its proposed Roydon extension to breed new mushroom cultures was successful.

Parish Council vice-chairman, Mr. Bob Lines, opposing the plans said Roydon Hall and grounds represented the last of the disappearing rural scene in an already over-developed village. The plan, involving 5,000 sq. ft. of floor space and the employment of only one or two workers there, was expected to go before the South Norfolk Planning Committee.

COVENT GARDEN MARKET

The Ministry of Agriculture announced on 18th March that the Covent Garden Market (Financial Provisions) Act 1977, which had received the Royal Assent the day before, enabled the Ministers of Agriculture to write off £13 million of the Authority's liabilities to the Government and to suspend interest and repayment liabilities on an additional sum not exceeding £25m.

Correspondence

FUEL ECONOMY and BOILER MAINTENANCE

May I ask for a small space in the Journal to appeal to any grower in the South East and South Central Area of England who is interested in fuel economy and boiler maintenance to contact:

Mr. R. Bailey, Agriculture Training Board, 59 London Road, Horsham, Sussex (Telephone — Horsham 62375)

I have been in touch with Mr. Bailey, who is in charge of Agricultural Training in this area. Already a number of courses are run at Wye College and elsewhere but these are primarily aimed at glass-house growers using space heating techniques and are not principally designed for mushroom growers. Subject to sufficient support being forthcoming, a two-day instructional course will be arranged aimed at improving the efficiency of oil burning units with the following principal objectives:

1. *To maintain the correct settings for efficient combustion.*
2. *The study of routine maintenance and the methods of carrying this out correctly and safely.*
3. *The study of systematic fault finding techniques and the methods for carrying out correct remedial action.*

Dependent upon support, courses will be arranged individually for 35 sec. oil and also for heavy oil, and the professional instructors are prepared to travel to any area where sufficient support is obtained. We have offered our own facilities here should they be required and if any other grower would be prepared to allow the use of his boiler house and tea-making facilities for two days the ATB would be very grateful to receive details.

At present the Agricultural Training Board have no facilities for instruction in plumbing and steam fitting techniques but would be prepared to consider arranging courses if there was sufficient interest. I am certain that this is one area where most growers could certainly save on outgoings if one of their staff had some knowledge, but as no facilities are at present available could you please drop me a line if you might be interested so that I can take it up again with the Agricultural Training Board, if it appears likely that there would be sufficient numbers to make a course worthwhile.

M. P. Dunn, Managing Director,
John Ady & Co. Ltd., Cranleigh, Surrey
(*Cranleigh* 2468).

GROWING PAINS

May I strongly support Barrie Hughes's plea for more 'Growing Pains'?

When I spoke to the diary's author a few weeks ago he felt that few growers were interested. Perhaps, if a sufficient number of growers lifted their pens in support, the author would reconsider his decision.

Raymond Thompson
Church Farm, Wittering, Chichester

HORST AND HAYES

As usual I read *The Mushroom Journal*, in this case the March issue, very attentively; in my opinion it is one of the best professional journals in this field.

In the interesting article by Smith and Fermor, I noticed that the diagram is not quite similar to the text. Where in the text it said the temperature is 50–55°C. (122–131°F.) the diagram shows about 60°C. (140°F.). I think the text is right. Furthermore I cannot bear to think of the quantities of energy which would be required to chop the large quantities of straw needed to make compost. (In Holland about 2,000 tons a week for 6,000 tons of compost.)

In the article about 'Commercial possibilities of Ready-Spawned Compost' I read: 'Peter Munns has heard that in Holland "False Truffle" had occurred in specially prepared spawned compost.' 'False truffle' has indeed occurred, but only in the last few years, for this disease had previously not been found here for many years. This, however, has nothing to do with infection during the transport of ready-spawned compost (whether or not in blocks), but with the growing of *A. bitorquis*. It is well known that with the high growth-temperature required for this species, the possibility of the occurrence of 'False Truffle' increases. (See my article 'Practical experience with *A. bitorquis*' in *Mushroom Journal*, No. 32, 1975.)

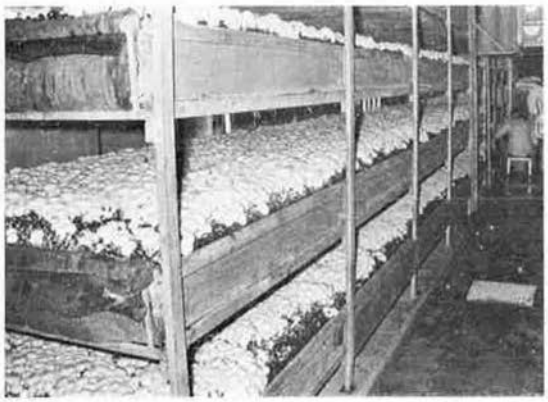
Naturally I was most interested in the letter by Hayes: 'British education for British Mushroom Growers'. I should like to make some remarks on it.

Dr. Hayes says that the methods of growing and circumstances in the UK and Holland differ so much, that a course for students from the UK

at The Mushroom Training Centre in Horst cannot but lead to confusion and misunderstanding. I am not convinced of that.

The basic facts for the cultivation of mushrooms seems to me to be the same throughout the world; it lies with the practical grower to adapt to changing conditions.

First, both countries do not differ much in climate. Secondly, the nitrogen percentage and the C/N ratio of a good compost should be generally the same in both countries. Thirdly, a compost which is good to fill trays with, is also good to be used in shelf-beds.



First break in one of the growing rooms of the instruction farm at the Training Centre at Horst. Confusion to the students and visitors . . . !

The basic facts for mass treatment of compost will also be the same in all countries.

Up until now I have visited quite a lot of mushroom farms in all parts of the world. Their problems were the same; the same diseases and pests, etc. If differences in cultivation, etc., between two countries in Europe should be so great that growers would become confused, then we had better stop organizing international congresses, reading foreign books and professional journals. Next, our experience is that groups of mushroom growers who attend a course at our school not only learn from us but also mutually discuss and exchange experiences, which is very important. Of late we have been visited by many mushroom growers from all over the world.

It is known that our farms and institutions are always open to anyone. It may be true that these visitors sometimes go back home a little confused and at a loss; however, for other reasons than those mentioned by Dr. Hayes. I can fully understand that Dr. Hayes thinks that British mushroom growers should have the opportunity to get their professional education in Britain. The reasons mentioned by him against a course at our Training Centre are, in my opinion, not to the point. In addition I hold the view that a University is not the most suitable training-college for the practising mushroom grower.

P. J. C. Vedder
Director
Mushroom Growers Training Centre
Horst

P.S. The only subject which receives less attention at Horst Training Centre is the nutritional value of mushrooms. On this subject, particularly, there seems to be great confusion.

PROTEIN AND MUSHROOMS

Nothing that has been written about mushroom protein in recent issues of *The Mushroom Journal* requires us to alter our contention that while, as far as protein content is concerned, the mushroom is at least as good as most vegetables (better than most though not as good as some) the large-scale cultivation of mushrooms is unlikely, in the forseeable future, to have more than a minimal effect on the diet of any nation.

P. B. Flegg and G. A. Maw
Glasshouse Crops Research Institute

Footnote: This protracted discussion should now cease.
Acting Editor.

BGLA 'LOOK AHEAD' CONFERENCE

The annual NFU British Growers 'Look Ahead' conference, held at Harrogate 1st–3rd March, attracted a record attendance of 8,000 people, 2,000 more than the previous 1976 record figure. At 250 stand bookings also established a new record.

Next year's Conference and Exhibition will also be held at Harrogate, on 21st, 22nd and 23rd February.

Mr. J. A. Gooding, the MGA Chairman, with John Bazalgette, the Director, attended this 1977 conference and exhibition.

NEW MUSHROOM TRAY CONTAINER

After more than fourteen months of close co-operation between Middlebrook Mushrooms and Remploy Ltd., a new 4-lb. (2-kilo) tray for marketing mushrooms has finally been approved by Middlebrook's, who have ordered a million of them.

Examining the tray are (*left to right*): Alan Milestone (Middlebrook's Marketing Director), Bill Hill (Middlebrook's General Manager), Peter Hill (Remploy's Bradford Factory Manager) and Ray Smees (Remploy's North-East Divisional Manager).

This new pack, thoroughly tested through picking, refrigeration and the market place, is claimed to stand up, when filled, to 56-lb. stacking pressure.

HORTICULTURAL WORKERS' AVERAGE WAGE

Figures provided by the Ministry of Agriculture show that for the year which ended in December 1976 the average earnings for workers in horticulture amounted to £46.49 for a 42.6 hours working week. The average figure for all male workers in agriculture and horticulture as a whole was £50.50 for a 46-hour week, with dairy-cowmen heading the list at £61 for a 52.8 hour week. This average figure of £50.50 for all male workers compares with £27.62 (1973), £34.52 (1974), £43.14 (1975). The prescribed wages under the Agricultural Wages Board Order for those years were: £23.64 (1973), £30.12 (1974), £38.24 (1975) and £46.00 (1976).

WHO SAID THAT?

J. P. G. Gerrits in *De Champignoncultuur*, May 1970.

SMALL ADVERTISEMENTS

8p per word

THE CHATSWORTH range of composters. 7 ft. Major Diesel, 6 ft. Major Electric, 4 ft. Loader-Fed Colt. Details from MORRIS GREEN MACHINERY, 69 Victoria Road, Worthing. Tel: 36211.

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