参考資料１　　バンコックのペナンマーケットでの販売価格

乾シイタケ	冬菇上	（韓国産）	kg当たり	1,500バーツ
	〃　並	（　〃　）	〃	1,300　〃
	香信　中小葉並	（日本産）	〃	1,000　〃
	〃　〃	（中国産）	〃	1,000　〃
白キクラゲ		（　〃　）	〃	800　〃
アラゲキクラゲ		（台湾産）	〃	550　〃
ギンナン		（中国産）	〃	150　〃
乾クリ		（　〃　）	〃	1,200　〃

参考資料２　　バンコックのヤワラマーケットでの販売価格

乾シイタケ	冬菇花	（日本産）	300ｇ入	650バーツ
	香信大中葉,並厚	（　〃　）	200ｇ入	300　〃
	冬菇並	（韓国産）	100ｇ入	150　〃
	〃　茶花	（　〃　）	kg当たり	1,500　〃
	〃　小玉	（　〃　）	〃	1,200　〃
	香信　中小葉	（　〃　）	〃	1,000　〃
缶詰	フクロタケ	（タイ産）	425ｇ	20　〃
	ツクリタケ	（　〃　）	〃	32　〃
	ヒラタケ	（　〃　）	〃	17　〃

参考資料３　　統計資料

表Ⅴ－1　乾燥きのこ類の輸出入

年	輸入		輸出	
	数量（トン）	金額（1,000バーツ）	数量（トン）	金額（1,000バーツ）
1980	47.33	18,610	18.19	4,071
1981	55.96	24,778	23.73	5,988
1982	42.12	16,950	47.42	6,492
1983	68.63	29,828	26.01	5,954
1984	76.86	37,994	38.31	8,047

出所：タイ貿易輸出入統計　以下同じ

表Ⅴ－2　相手国別乾燥きのこ類輸入

相手国	数量（トン）			金額（1,000バーツ）		
	1982	1983	1984	1982	1983	1984
中国	16.50	13.89	8.00	4,941	3,712	2,691
香港	0.72		0.08	240		45
日本	2.55	5.14	5.11	1,558	3,160	3,408
韓国	19.23	46.75	59.52	9,039	22,048	30,514
台湾	3.02	2.76	4.01	1,072	864	1,278
合計（その他を含む）	42.12	68.63	76.86	16,950	29,823	37,994

表Ⅴ－3　相手国別乾燥きのこ類輸出

相手国	数量（トン）			金額（1,000バーツ）		
	1982	1983	1984	1982	1983	1984
サウディ・アラビア	16.15	3.00	2.62	650	491	596
シンガポール	5.89	0.30		75	3	
スリ・ランカ	16.88			4,991		
フランス		13.48	17.36		3,766	5,129
西ドイツ	0.06	6.62	3.91	13	1,317	752
米国	7.06	1.93	10.57	570	261	909
合計（その他を含む）	47.42	26.01	38.31	6,492	5,954	8,047

表Ⅴ－4　きのこ類缶詰の輸出入

年	輸入		輸出	
	数量（トン）	金額（1,000バーツ）	数量（トン）	金額（1,000バーツ）
1980	0.05	3	14.50	342
1981	0.07	5	7.44	289
1982	0.09	10	7.55	299
1983	0.04	3	9.19	315
1984	1.37	26	34.19	1,698

表Ⅴ－５　相手国別きのこ類缶詰輸入

相手国	数量（トン）			金額（1,000バーツ）		
	1982	1983	1984	1982	1983	1984
日本	0.09	0.04		10	3	
台湾			1.37			26
合計（その他を含む）	0.09	0.04	1.37	10	3	26

表Ⅴ－６　相手国別きのこ類缶詰輸出

相手国	数量（トン）			金額（1,000バーツ）		
	1982	1983	1984	1982	1983	1984
サウディ・アラビア	0.48	5.40	17.93	41	210	714
フランス			1.54			457
米国	4.58	2.35	12.00	159	75	431
オーストラリア	1.43		2.29	61		80
合計（その他を含む）	7.55	9.19	34.19	299	315	1,698

表Ⅴ－７　生鮮タケノコの輸出入

年	輸入		輸出	
	数量（トン）	金額（1,000バーツ）	数量（トン）	金額（1,000バーツ）
1980	1.27	24	119.42	861
1981	1.30	41	35.40	446
1982	0.39	4	230.82	2,275
1983	17.62	599	288.76	5,125
1984	11.30	471	338.67	8,787

表Ⅴ－８　相手国別生鮮タケノコ輸入

相手国	数量（トン）			金額（1,000バーツ）		
	1982	1983	1984	1982	1983	1984
中国	0.39	0.49		4	8	
香港		0.63	1.05		23	56
台湾		16.48	10.00		567	392
シンガポール		0.02	0.25		1	23
合計（その他を含む）	0.39	17.62	11.30	4	599	471

表Ⅴ－9　相手国別生鮮タケノコ輸出

相手国	数量（トン）			金額（1,000バーツ）		
	1982	1983	1984	1982	1983	1984
日本	69.30	110.53	36.87	635	979	305
マレイシア	5.48	2.27	49.28	123	68	961
サウディ・アラビア	23.94	7.03	17.96	371	70	493
シンガポール	38.92	134.63	181.77	423	3,276	6,244
フランス	8.40		20.34	81		226
米国	67.77	16.50	23.90	296	226	429
合計（その他を含む）	230.82	288.76	338.67	2,275	5,125	8,787

表Ⅴ－10　乾燥タケノコの輸出入

年	輸入		輸出	
	数量（トン）	金額（1,000バーツ）	数量（トン）	金額（1,000バーツ）
1980	106.91	9,128	5.28	57
1981	218.44	11,277	118.78	1,403
1982	135.88	11,634	97.33	1,253
1983	182.32	15,711	29.69	2,971
1984	119.73	11,004	15.22	1,112

表Ⅴ－11　相手国別乾燥タケノコ輸入

相手国	数量（トン）			金額（1,000バーツ）		
	1982	1983	1984	1982	1983	1984
中国	129.78	180.09	110.28	11,106	15,429	10,166
香港	5.14		1.01	440		87
台湾	0.96		2.83	82		242
インドネシア		1.92			164	
日本		0.26	5.34		26	445
合計（その他を含む）	135.88	182.32	119.73	11,634	15,711	11,004

表Ⅴ－12　相手国別乾燥タケノコ輸出

相手国	数量（トン）			金額（1,000バーツ）		
	1982	1983	1984	1982	1983	1984
日本	82.60	28.87	13.20	849	2,852	1,001
米国	13.61	0.82	1.46	380	118	66
合計（その他を含む）	97.33	29.69	15.22	1,253	2,971	1,112

表V－13　タケノコ缶詰の輸出入

年	輸入		輸出	
	数量（トン）	金額（1,000バーツ）	数量（トン）	金額（1,000バーツ）
1980	0.05	3	14.50	342
1981	0.07	5	1,736.32	22,735
1982	0.09	10	3,601.35	50,746
1983	0.15	28	5,869.13	81,861
1984	2.36	82	8,557.90	91,971

表V－14　相手国別タケノコ缶詰輸入

相手国	数量（トン）			金額（1,000バーツ）		
	1982	1983	1984	1982	1983	1984
中国		0.15	0.95		28	39
日本	0.09			10		
台湾			1.39			42
合計（その他を含む）	0.09	0.15	2.36	10	28	82

表V－15　相手国別タケノコ缶詰輸出

相手国	数量（トン）			金額（1,000バーツ）		
	1982	1983	1984	1982	1983	1984
香港	371.12	171.26	391.44	4,435	1,429	3,704
日本	1,575.78	3,754.92	5,964.25	18,477	50,937	54,450
サウディ・アラビア	331.72	412.04	521.10	6,024	7,308	8,450
シンガポール	45.16	78.33	129.03	475	740	1,168
デンマーク		137.51	166.35		1,569	1,819
フランス	12.56	131.98	144.72	1,183	2,032	1,935
西ドイツ	230.11	168.68	178.17	3,829	2,876	2,807
イギリス		137.44	61.25		1,829	711
米国	744.05	624.01	693.25	12,991	9,528	12,381
オーストラリア		71.60	106.18		1,026	1,272
合計（その他を含む）	3,601.35	5,869.13	8,557.90	50,746	81,861	91,971

4. 投資環境

(1) 経済概況

① 特徴

タイは稲作の盛んな国であり，米の輸出額は総輸出額の１５％近くを占めている。米の他にも農業の多角化，多様化によりキャッサバやメイズ等いくつかの農林水産物が主要な輸出商品となっている（表Ⅴ－１６）。このように，タイでは稲作を中心とする農林水産業が基幹産業となっており，農林水産業の比重の高いことがタイ経済の特徴といえる。

工業化の進展については，多くの開発途上国のように性急な重化学工業化政策をとらず，技術水準，資本量の限界等を考慮した軽工業中心のゆるやかな工業化を選択し，１９６０年代の成長の大きな要因となっている。その後，１９７０年代に入って石油危機等種々の困難に遭遇し現在に至っているが，特に第２次石油危機の影響による世界経済の低迷は，タイの主要輸出品である一次産品の価格の下落，海外金利の高騰等を通じてタイ国内経済に大きな影響を及ぼしてきている。

最近の経済の動向を国内総生産（ＧＤＰ）でみると，その実質経済成長率（１９７２年基準）は１９８１年は農業部門の好調に支えられて6.3％，１９８２年は天候不順等による農業生産の不振，国内需要の減退等により4.1％，１９８３年は農業生産の好転，国内建設投

表Ⅴ－１６　農林水産物の輸出シェア

（単位：百万ＵＳドル，％）

	１９８２		１９８３		83／82
	金　額	構成比	金　額	構成比	
総輸出額	6,975.03	100.0	6,385.98	100.0	91.6
Ⅰ 農林水産物	4,337.26	62.2	3,835.74	60.1	88.4
(1) 米	1,003.66	14.4	896.75	14.0	89.3
(2) タピオカ製品	862.37	12.4	671.76	10.5	77.9
(3) メイズ	363.83	5.2	370.66	5.8	101.9
(4) ゴム	414.79	5.9	513.34	8.0	123.8
(5) 砂糖	564.70	8.1	275.96	4.3	48.9
(6) 水産物	471.74	6.8	527.86	8.3	111.9
(7) その他	656.17	9.4	579.41	9.1	88.3
Ⅱ 工業製品	1,493.11	21.4	1,631.81	25.6	109.3
Ⅲ 鉱産物	422.85	6.1	291.39	4.6	68.9
Ⅳ その他	718.16	10.3	623.52	9.8	86.8

資料："Thailand Exports 81－83" 商務省商業経済局

資・設備投資が活発であったことから5.8％となっている（表Ⅴ－17）。農林水産業がタイ経済の基盤となっていることはこの産業別ＧＤＰの構成比からもうかがえ，１９８３年の農林水産業の構成比２３.６％は製造業の２１.０％上回り最大の産業部門となっている。

表Ⅴ－17　産業別GDP（１９７２年価格）

	金額（百万バーツ）			増減率（％）			構成比（％）		
	1981	1982	1983	1981	1982	1983	1981	1982	1983
農林水産業	77,701	78,502	80,940	6.8	1.0	3.1	25.0	24.2	23.6
農業	58,528	59,904	61,827	8.0	2.4	3.2	18.8	18.5	18.0
畜産業	9,500	9,897	10,144	5.4	4.2	2.5	3.1	3.1	3.0
水産業	6,777	6,019	6,502	8.0	△11.2	8.0	2.2	1.9	1.9
林業	2,896	2,682	2,467	△12.7	△ 7.4	△8.0	0.9	0.8	0.7
鉱業，採石業	4,623	4,431	4,368	△ 3.3	△ 4.2	△1.4	1.5	1.4	1.3
製造業	64,490	67,317	71,947	6.4	4.4	6.9	20.7	20.8	21.0
建設業	15,500	15,097	15,843	△ 6.5	△ 2.6	4.9	5.0	4.7	4.6
電力，水道	6,330	6,755	7,394	13.8	6.7	9.5	2.0	2.1	2.2
運輸，通信	20,209	21,715	23,609	7.4	7.5	8.7	6.5	6.7	6.9
卸小売り	51,103	52,789	55,592	6.0	3.3	5.3	16.4	16.3	16.2
銀行，保険，不動産	19,197	21,396	24,330	10.2	11.5	13.7	6.2	6.6	7.1
住宅保有	4,723	4,936	5,152	4.9	4.5	4.4	1.5	1.5	1.5
行政，国防	13,192	13,833	14,399	6.2	4.9	4.1	4.2	4.3	4.2
サービス業	34,202	37,261	39,304	9.7	8.9	5.5	11.0	11.5	11.5
ＧＤＰ	311,270	324,032	342,878	6.3	4.1	5.8	100.0	100.0	100.0
海外からの純所得	△12,986	△14,910	△14,496						
ＧＮＰ	298,284	309,122	328,382	4.8	3.6	6.2			
1人当りGNP(バーツ)	6,281	6,682	6,933	2.5	6.4	3.8			

資料：National Income of Thailand（1983）

② 貿易収支

タイ国の国際収支は，恒常的な貿易収支の赤字を貿易外収支及び資本収支の黒字で補填するパターンをとってきている。貿易赤字の原因は輸出商品が農水産物，鉱物等の一次産品に過度に依存しており，天候や国際商品市況の動きに影響され易く不安定なこと及び国際競争力のある輸出工業がまだ十分発展していないため，大幅な量的拡大が短期的には困難であるのに対し，輸入は原油，原材料，資本財が多く，タイ国経済の発展に応じ増大傾向を辿り，特に好況期の生産財輸入増大が著しいことによるものであると言われている。

１９８３年には世界的な景気回復基調の中でタイ国経済も活況を呈し，生産財原材料を中心に前年比２０.５％の輸入増大となり逆に輸出は前年比7.8％の減少を示した結果，貿易

収支赤字は３８億ドルと過去最高となった（表Ｖ－１８）。

輸出の商品構成は米１３.８％，タピオカ製品１０.５％などとなっており（表Ｖ－１９），輸入の商品構成は消費財１２.６％，原料・中間製品２５.２％，資本財２９.３％，その他３２.９％となっている（表Ｖ－２０）。

表Ｖ－18　国際収支推移

（単位：百万ドル）

	1970	1979	1980	1981	1982	1983
A 貿易収支						
輸出（FOB）	681.8	5,234.1	6,447.6	6,901.9	6,834.9	6,306.0
輸入（CIF）	△1,266.9	△7,538.4	△9,277.0	△9,924.4	△8,406.1	△10,136.2
バランス	△ 585.1	△2,304.3	△2,829.4	△3,022.5	△1,571.2	△ 3,830.2
B 貿易外収支						
旅行	43.1	322.4	623.6	706.5	770.8	747.0
投資収益	18.1	△ 445.9	△ 570.6	△ 941.3	△1,086.2	△ 1,027.8
政府	212.4	56.0	87.5	32.7	31.8	56.7
その他	14.8	226.1	403.4	486.1	666.0	959.0
C 移転収支	48.3	59.9	216.2	169.4	182.8	268.1
経常収支（A+B+C）	△ 248.4	△2,085.8	△2,069.3	△2,569.1	△1,006.0	△ 2,827.2
D 資本収支						
直接投支	42.6	51.3	186.8	287.1	187.1	347.2
その他民間（長期）	64.2	1,009.0	1,617.8	1,702.6	1,108.1	679.5
その他民間（短期）	8.8	174.7	374.0	133.4	41.7	164.9
政府	2.9	418.6	303.5	362.3	330.3	327.7
SDR割当	—	24.2	24.8	23.6	—	—
誤差脱漏	3.2	19.9	180.1	142.7	△ 517.1	521.9
総合収支	△ 126.7	△ 388.1	257.5	82.6	144.1	△ 786.0

資料：Bank of Thailand 月報

表Ｖ－19　主要一次産品別輸出額

（単位：百万バーツ）

暦年 / 品目	1960		1970		1975		1980		1981		1982		1983	
	金額	%	金額	%	金額	%	金額	%	金額	%	金額	%	金額	%
① 米	2,570	29.8	2,516	17.0	5,852	13.0	19,508	14.6	26,353	17.2	22,510	14.1	20,142	13.8
② タピオカ製品	288	3.3	1,223	8.3	4,597	10.2	14,887	11.2	16,434	10.7	19,752	12.4	15,387	10.5
③ 生ゴム	2,579	29.9	2,232	15.1	3,474	7.7	12,351	9.3	10,839	7.1	9,490	5.9	11,787	8.0
④ 砂糖	8	0.1	94	0.6	5,696	12.7	2,975	2.2	9,571	6.3	12,932	8.1	6,338	4.3
⑤ 錫	537	6.2	1,618	11.0	2,247	5.0	11,347	8.5	9,099	5.9	7,773	4.9	5,263	3.6
⑥ メイズ	551	6.4	1,969	13.3	5,705	12.7	7,299	5.5	8,328	5.4	8,330	5.2	8,486	5.8
その他	2,087	24.2	5,120	34.7	17,436	38.7	64,830	48.7	72,406	47.3	78,941	49.4	79,034	54.0
計	8,612	100.0	14,772	100.0	45,007	100.0	133,197	100.0	153,030	100.0	159,728	100.0	146,437	100.0

資料：Bank of Thailand

表Ｖ－20　財別輸入実績

（単位：百万バーツ）

商品分類＼歴年	1960	1970	1975	1980	1981	1982	1983
Ⅰ 消費財	3,365 (35.0)	5,229 (19.4)	8,455 (12.7)	19,286 (10.2)	22,985 (10.6)	22,783 (11.6)	29,834 (12.6)
1. 非耐久財	2,258	3,486	5,148	12,257	13,616	12,991	16,008
2. 耐久財	807	1,743	3,307	7,029	9,369	9,792	13,826
Ⅱ 原料及び中間製品	1,746 (18.1)	6,725 (24.9)	16,105 (24.1)	45,312 (24.0)	53,575 (24.7)	48,596 (24.7)	59,462 (25.2)
1. 消費財用	1,030	4,139	10,318	28,182	33,716	30,427	37,247
（うち）繊維材料	60	602	1,902	3,175	3,915	3,247	4,522
2. 資本財用	716	2,586	5,787	17,130	19,859	18,169	22,215
（うち）鉄鋼	568	1,647	3,236	10,335	12,093	11,323	13,722
Ⅲ 資本財	2,367 (24.6)	9,371 (34.7)	22,239 (33.3)	46,075 (24.4)	56,772 (26.2)	47,778 (24.3)	69,346 (29.3)
（うち）機械（電気を除く）	1,021	4,723	11,973	20,402	25,842	21,172	33,160
（同）電気機械及び部品	334	1,419	2,730	11,206	10,867	11,008	15,843
Ⅳ その他	2,144 (22.3)	5,684 (21.0)	20,036 (30.0)	78,013 (41.3)	83,414 (38.5)	77,459 (39.4)	77,719 (32.9)
（うち）自動車及び部品	—	2,204	4,542	6,912	9,568	7,687	11,224
（同）原油及び石油製品	—	2,329 (8.6)	14,233 (21.3)	58,733 (31.1)	56,040 (25.9)	60,765 (30.9)	57,040 (24.1)
合計	9,622 (100.0)	27,009 (100.0)	66,835 (100.0)	188,686 (100.0)	216,746 (100.0)	196,616 (100.0)	236,361 (100.0)

資料：Bank of Thailand

③ 物　価

１９８３年の消費者物価についてみると，上期の干ばつ，下期の洪水により食料費が5.0％上昇したものの，非食料費の上昇率が大幅に低下したため，総合では3.8％の上昇にとどまっている（表Ｖ－２１）。また卸売物価についても，農産物及び食料品が6.1％の上昇を示したものの，工業品が△1.4％の低下となったため，総合では2.0％の上昇にとどまっている（表Ｖ－２２）。このように，物価については１９８２年以降安定化の傾向を示している。

表Ⅴ－21　消費者物価指数（全国，1976年＝100）

	1978	1979	1980	1981	1982	1983
総合	(7.9) 116.1	(9.9) 127.6	(19.7) 152.7	(12.7) 172.1	(5.2) 181.1	(3.8) 187.9
食料	(8.9) 119.1	(9.1) 129.9	(19.6) 155.4	(10.6) 171.8	(2.8) 176.6	(5.0) 185.5
非食料	(6.8) 112.0	(10.5) 123.8	(19.9) 148.4	(14.2) 169.5	(7.3) 181.8	(2.7) 186.7
衣料	(5.1) 109.6	(13.7) 124.6	(20.3) 149.9	(10.0) 164.9	(5.5) 173.9	(3.8) 180.5
住居	(5.4) 111.2	(9.8) 122.1	(19.3) 145.7	(13.3) 165.1	(7.2) 177.0	(4.4) 184.7
医療	(9.1) 115.1	(6.9) 123.0	(20.7) 148.4	(10.2) 163.5	(6.5) 174.1	(3.2) 179.6
交通	(14.8) 118.4	(16.7) 138.2	(24.2) 171.7	(28.5) 220.6	(4.8) 231.2	(0.6) 232.5
教養・娯楽・教育	(6.4) 109.5	(10.4) 120.9	(19.4) 144.4	(10.1) 159.0	(8.2) 172.1	(2.1) 175.8
タバコ・アルコール飲料	(2.7) 110.0	(2.7) 113.0	(10.9) 125.3	(11.4) 139.6	(17.8) 164.4	(△2.8) 159.8

注：（ ）内は前年比上昇率
資料：商務省経済局

表Ⅴ－22　卸売物価指数（全国，1976＝100）

	1978	1979	1980	1981	1982	1983
総合	(7.4) 115.8	(11.2) 128.8	(20.1) 154.7	(9.6) 169.5	(0.9) 171.0	(2.0) 174.5
農産物及び食料品	(6.3) 114.8	(5.0) 120.5	(22.2) 147.2	(10.0) 161.9	(△2.2) 158.4	(6.1) 168.0
工業品	(8.6) 116.8	(17.0) 136.7	(18.3) 161.7	(9.1) 176.4	(3.7) 182.9	(△1.4) 180.4

注：（ ）内は前年比上昇率
資料：商務省経済局

④ 財　　政

１９８４年度の財政規模は歳出予算額で1,９２０億バーツ，政府経常収入予算額で1,６００億バーツとなっており，３２０億バーツの赤字予算である（表Ⅴ－２３，表Ⅴ－２４）。この財政赤字は慢性的に生じており，これを改善し財政バランスを回復するため，第５次国家経済社会開発５カ年計画では「経済及び財政の安定化」を重要な目標の一つとして掲げている。財政赤字は，中央銀行，政府貯蓄銀行，民間商業銀行等からの借入金によってファイナンスされる。

１９８２年末のタイ国公的対外債務は６０.1億ドル（政府直接借入れ２１億ドル，政府保証公団借入れ３８.７億ドル，政府保証なし公団借入れ０.４億ドル）となっており，他の開発途上国に比較して低い水準にある。また，いわゆるエクスターナル・デット・サービス・レシオは１９８２年で８.９％（民間部門元利返済を含めると１６.７％）となっている。

(2) 農林業の現状

① 農　　業

タイの農地面積は1,９４１haで国土面積5,１４０万haの３７.８％を占めている。農地面積の６１％は水田であり，稲作を中心とする農業であることが理解できる。農家数は4,５３２千戸で，一戸当りの農地は４.２８haとなっている（表Ⅴ－２５）。１９７８年の農業センサスによれば，自作農は３４２万戸で農家数４０２万戸の８５％を占め，残りの１５

表Ⅴ－２３　歳出予算の推移及びＧＤＰ比

（単位：１００万バーツ　％）

年度	歳出予算額 (a)	対前年度伸率	歳出決算額 (b)	対前年度伸率	名目ＧＤＰ (c)	(a)/(c)	(b)/(c)
1976	62,650.0	24.1	59,233.6	28.0	337,635.0	18.6	17.5
1977	68,790.0	9.8	65,528.3	10.6	393,030.0	17.5	16.7
1978	81,000.0	17.8	78,481.1	19.8	469,952.0	17.2	16.7
1979	92,000.0	13.6	91,841.3	17.0	556,240.0	16.5	16.5
1980	114,556.5	24.5	111,201.1	21.1	684,930.0	16.7	16.2
1981	140,000.0	22.2	135,011.9	21.4	786,166.0	17.8	17.2
1982	161,000.0	15.0	148,971.0	10.3	846,136.0	19.0	17.6
1983	177,000.0	9.9	149,173.3	0.1	928,548.0	19.1	16.0
1984	192,000.0	8.5	—	—	1,039,300.0	18.5	18.5
1985	213,000.0	10.9	—	—	1,173,900.0	18.1	18.2

注：1. １９８３年度の決算額は決算見込。

2. 名目ＧＤＰのうち，１９８３年度は速報暫定値，1984－1985年度は見込。

資料：Thailand Budget in Brief（FY1985）

表Ⅴ－24　政府経常収入の推移及びＧＤＰ比

（単位：100万バーツ）

年度	政府経常収入 予算額 (a)	対前年度伸率	政府経常収入 決算額 (b)	対前年度伸率	名目ＧＤＰ (c)	(a)/(c)	(b)/(c)
1976	48,675.0	26.4	42,915.9	11.5	337,635.0	14.4	12.7
1977	50,470.0	3.6	52,157.9	21.5	393,030.0	12.8	13.3
1978	62,000.0	22.8	62,142.9	19.1	469,952.0	13.2	13.2
1979	72,000.0	16.1	75,089.8	20.8	556,240.0	12.9	13.5
1980	92,680.0	28.7	92,689.8	23.4	684,930.0	13.5	13.5
1981	120,000.0	29.5	110,486.0	19.2	786,166.0	15.3	14.1
1982	140,000.0	16.7	113,654.1	2.9	846,136.0	16.5	13.4
1983	151,000.0	7.9	137,450.9	32.0	928,548.0	16.3	14.8
1984	160,000.0	6.0	156,000.0	—	1,039,300.0	15.4	15.0
1985	178,000.0	—	—	—	1,173,900.0	15.2	—

注：1. 1984年度の決算額は決算見込。

2. 名目GDPのうち，1983年度は速報暫定値，1984－1985年度は見込。

資料：Thailand Budget in Brief

表Ⅴ－25　農地面積及び農家数（1981年）

A 国土面積	千km^2	514 (5,140万ha)
B 農地	千ha	19,407
(1) 水田	〃	11,764
(2) 畑地	〃	4,382
(3) 樹園地	〃	1,826
(4) 草地	〃	122
(5) その他	〃	1,313
B／A農地率	%	37.8
C 農家数	千戸	4,532
B／C一戸当たり農地	ha	4.28

資料：タイ，"Agricultural Statistics of Thailand"，
農業・協同組合省

%は小作農（23万戸），自小作農（28万戸），土地なし（借地もしていない）農家（4万8千戸）となっている。土地なし農家はいわゆる農業労働者であり，農家全体の1.2%と極めて少なく，これらの70%は北部及び中央タイの稲作地帯に分布している。

国内総生産額に占める農業総生産額（名目，GDP）の割合は表Ⅴ－２６のとおりであり，農業は１６.０％となっている。農業部門内の生産額は米が一番多く，産業部門の約３割を占めている。次いで果物が約２割となっており，マンゴ，パイナップル，パパイヤ等の果物が豊富なことによるものと思われる。その他では，砂糖きび，キャッサバなど輸出向の作物の割合が高くなっている。農業人口１人当たりの所得についてみると，１９８２年では全国平均で5,３３７バーツであり，他産業の所得と比べると７分の１程度と極めて格差が大きい（表Ⅴ－２７）。また，地域による格差も大きく，最も所得の低い東北部は中央部の３分の１程度である。

表Ⅴ－２６　農業総生産額（1983年）

	百万バーツ	構成比
総生産額（GDP）	９２８,５４８	１００.０％
農林水産業	２０２,７９７	２１.８
農業	１４８,９８２	１６.０
畜産業	２７,９２２	３.０
水産業	１４,９９８	１.６
林業	１０,８９５	１.２
農業内訳	(１４８,９８２)	(１００.０)
米	４９,６０６	(３３.３)
天然ゴム	１０,６３８	(７.１)
ココナッツ	１,０５２	(０.７)
砂糖きび	１３,７６１	(９.２)
メイズ，ソルガム	６,７５５	(４.５)
落花生	１,９４８	(１.３)
マング・ビーン	２,３５９	(１.６)
ひま	１３４	(０.１)
大豆	７１２	(０.５)
キャッサバ	１１,０６３	(７.４)
タバコ	４,７１５	(３.２)
綿	１,３２１	(０.９)
ケナフ，ジュート，ラミー	１,０６８	(０.７)
カポック	３４４	(０.２)
ごま	２６８	(０.２)
にんにく，たまねぎ，シャロット，チリ	７,５４６	(５.１)
野菜	１０,０４５	(６.７)
果物	２４,７１３	(１６.６)
その他	９３４	(０.６)

資料：農業・協同組合省

資料Ｖ－２７　農業人口１人当り所得

（単位：バーツ／１人当り）

	農業人口１人当り所得					非農業人口１人当り所得	比率
	①	東北部	北部	中央部	南部	②	②／①
1978年	4,199	2,285	4,399	6,697	5,695	23,728	1：5.65
1979	4,696	2,769	4,874	7,036	6,496	27,143	1：5.78
1980	5,445	3,221	5,444	8,355	7,499	32,346	1：5.94
1981	5,773	3,068	6,207	9,528	7,104	36,154	1：6.26
1982	5,337	2,831	5,579	8,755	6,894	39,350	1：7.37

資料：Office of Agricultural Economics Office of the National Economic and Social Development

１９５０年初の時点では全作付面積の９割程度が米によって占められていたとみられるが，その後のタイ国経済の資本主義的な展開の中で伝統的な農村社会も商品経済の波の中に巻き込まれ，砂糖きび，メイズ，キャッサバ，ゴムなどの現金収入をもたらす商品作物の生産拡大が急速に進んできた。こうした農業生産の増大は主として森林原野の開墾等による作付面積の増大（表Ｖ－２８）によってもたらされたため，一方では森林面積の急激な減少をもたらしている。もちろん，森林面積の減少は農業開発のみならず長期にわたる乱伐，薪炭用等木材需要の増大，不法定住・焼畑等によるところも大きい。森林は，木材供給源であるのみならず自然環境の保全，水資源のかん養，洪水・土砂流出の防止等の多面的な機能を果たしていることから，今後は荒廃した森林の回復と森林・林業と調和した農業発展が望まれている。

なお，第５次国家経済社会開発計画では，１９８６年の産業別労働力構成について，農林水産業部門を１８，５９４千人とし全体の６９％に設定し，依然，農業を中心とする農林水産業労働力がタイの労働力の中核となることを明らかにしている。

表Ｖ－２８　主要作物の作付面積の拡大状況

（単位：千ヘクタール）

	1950/51(A)	1982/83(B)	（B／A）
米	5,540	9,621	1.7
メイズ	34.9	1,679	48.1
キャッサバ	13.6	1,236	90.9
砂糖きび	53.9	583	10.8
ゴム	316.0	1,600	5.1

資料："Agricultural Statistics of Thailand"
農業・協同組合省

② 林　　業

タイの森林面積は王室林野局の調査によれば１９８２年時点で全国土面積の３０.５％に当たる1,５６６万haとなっている（表Ｖ－２９）。これは，人工衛星ランドサットからの写真解析に基づくものであり，９年前の１９７３年には２,２１７万haと国土の４３％であったことからすると大幅な森林の減少となっている。この森林面積の減少の最大の要因は，急速に輸出が伸びたキャッサバ等を栽培するための農地の開墾（焼畑）であった。また，人口増加に伴う農村の主要燃料としての薪炭需要が増加し，森林伐採が行われてきたこと，植林のための造林投資が進まなかったこと等も要因としてあげることができる。

森林の所有形態については，歴史的には地方領主の私的財産として認められていたが，現在ではほとんどの森林が国の所有となっている。森林の管理については，中央森林管理と地方森林管理の２つに分かれている。中央森林管理に係る行政機関としては王室林野本局（１３部）と地方営林局（２１カ所）があり，国立公園と鳥獣保護の業務も行っている。地方森林管理については県が掌握し，その管轄下に県営林所（７２カ所），郡営林所（５８８カ所），王立郡営林所（６５カ所）がある。

造林については，第５次国家経済社会開発計画（１９８２年～１９８６年）において年間４万８,０００haの原野造林を目標として掲げているが，資金面の制約があることからその進展は遅々としている。ちなみに，１９８２年の植林面積は１９,３１４haとなっている。

表Ｖ－２９　森林面積の推移

（単位：1,０００ヘクタール）

	国土面積	森林面積			森林減少面積
	Ⓐ	1973 Ⓑ	1978 Ⓒ	1982 Ⓓ	Ⓓ－Ⓒ
北部	(100.0)	(67.0)	(56.0)	(51.7)	
	16,964	11,360	9,494	8,776	718
東北部	(100.0)	(30.0)	(18.5)	(15.3)	
	16,885	5,067	3,122	2,589	533
中央部	(100.0)	(37.5)	(30.3)	(24.8)	
	10,390	3,900	3,146	2,652	494
南部	(100.0)	(26.1)	(24.9)	(23.3)	
	7,072	1,844	1,760	1,644	116
合計	(100.0)	(43.2)	(34.2)	(30.5)	
	51,311	22,171	17,522	15,660	1,862

資料：王室林野局

木材生産量をチーク，ヤーン及びその他木材についてみると表Ｖ－３０のとおりである。１９７７年の丸太輸出禁止措置を契機に生産量は減少し，１９８２年の木材生産量（１７１万㎥）は１９７７年のそれ（３３４万㎥）の５１.０％と半減している。しかし，製材としての生産額は１９７７年の５９億バーツに対し１９８２年は９０.０％と生産量の減少ほど激しく落ち込んでいない。チーク材は北部タイを主産地としていたが，近年，その資源は急速に枯渇した。その他木材は薪・炭利用部分が多く，最近その利用量は増加している（表Ｖ－３１）。

木材の貿易については，タイは数量及び金額ともに輸入国に転じている。輸入される主要な木材は，ダウ，メルサワ，カリンなどで近隣諸国（マレイシア，インドネシア，ビルマ）から輸入されている。輸出はチーク材，竹材などが主たるもので，アメリカ，香港向けに輸出されている。

政府は，１９７７年以降丸太木材の輸出を禁止し，森林保護と植林の指導を強めるとともに，木材の輸出については，附加価値を高めた加工木材の型での輸出を指導してきている。

表Ｖ－３０　木材生産量の推移

（単位：1,000㎥）

	チーク	ヤーン	その他木材	計
1961年	106	319	858	1,283
1970	234	447	1,404	2,085
1977	138	990	2,212	3,340
1978	112	477	2,021	2,610
1980	97	551	1,896	2,544
1981	73	289	1,436	1,798
1982	58	341	1,306	1,705

資料：王室林野局

表Ｖ－３１　薪炭向け生産量

（単位：1,000㎥）

	薪	炭	計
1980年	636	234	870
1981	643	257	900
1982	857	340	1,197

資料：王室林野局

(3)　政府の外資政策

タイ政府の外資に対する方針は時代の流れとともに変化してきている。１９５４年に産業奨励法が制定されたが，この時期は政府主導型の産業育成であり，民間主導型の積極的な外資

導入政策がとられることになったのは１９６２年の産業投資奨励法によってである。その後，外資の大量進出に対する反発，ナショナリズムの高揚を転機として，１９７２年には投資奨励法，外国企業規制法，外国人職業規制法が制定され，それまでの自由主義的な外資政策から外資選別政策へ転換した。これら外資に対する諸規制，タイ国内における労働争議，インドシナ情勢の変化等を背景として１９７５年以降外資の流入が停滞したため，外国資本の誘致を政策重点項目に掲げ，１９７７年新しい投資奨励法を施行することとなった。しかし，その改正の狙いは投資委員会の権限を強化するとともに，手続面での能率化を図ることに主眼がおかれており，外資政策そのものは１９７２年の投資奨励法の精神をそのまま継承していると言える。また，外国企業規制法，外国人職業規制法等も引き続き存続している。

タイのこのような外資政策は今後も引き続くものと思われ，また，資本のタイ化，タイ人の登用，産品の輸出義務等々各種の制約は今後も強められるものと思われることから，投資に当たっては，常にこの制約を念頭に入れておく必要がある。

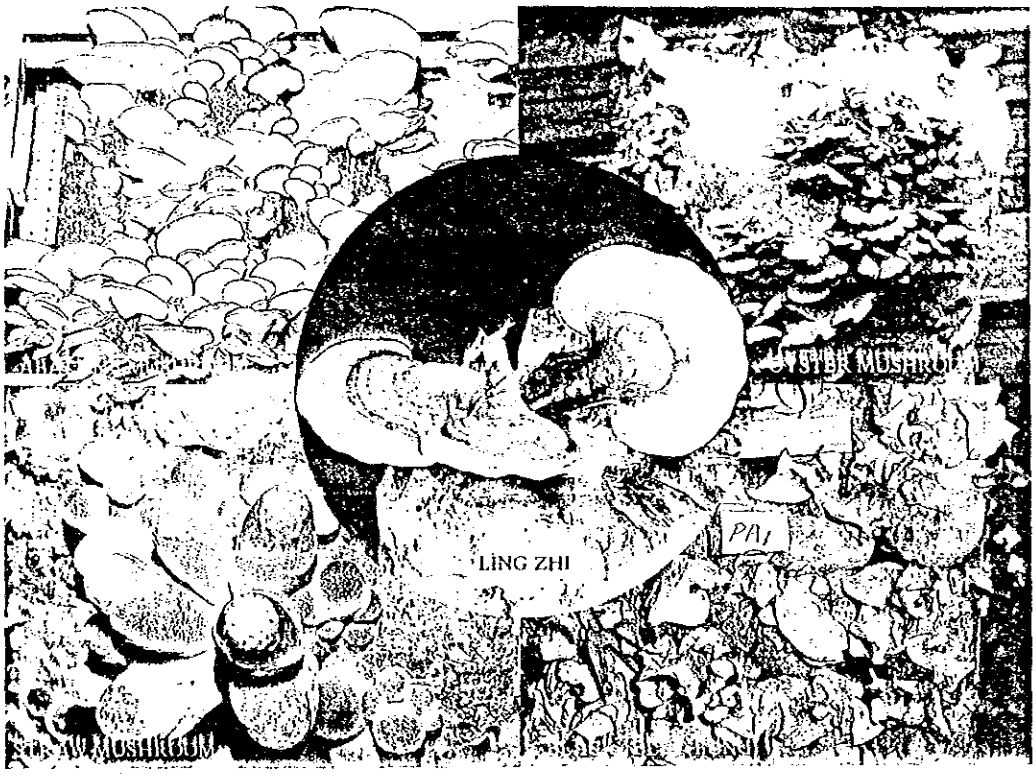
また，従来国際比較において低い水準にあった労働賃金が，毎年実施される最低賃金の引き上げ等々の措置を通じて今後ともレベルアップされることが予想され，極めて低い水準の賃金を期待することは次第に難しくなってきていること，ビザ，ワークパーミット，関税還付等の窓口での処理が遅いこと，企業個人に対する課税方法が場当たり的で不統一であったり実務的にも極めて煩瑣であること，公害についての規制が当然のことながら厳しくなってきていること等についても留意する必要がある。

添　付　資　料

AGRICULTURE HANDBOOK NO. 6

A GUIDE TO CULTIVATION OF EDIBLE MUSHROOMS IN SINGAPORE

T.A. YONG and P.C. LEONG



PRIMARY PRODUCTION DEPARTMENT
MINISTRY OF NATIONAL DEVELOPMENT
REPUBLIC OF SINGAPORE

A Guide To Cultivation Of Edible Mushrooms In Singapore

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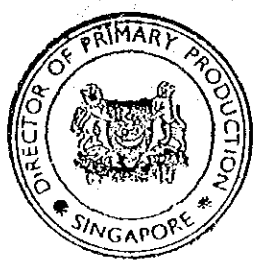

PRIMARY PRODUCTION DEPARTMENT
MINISTRY OF NATIONAL DEVELOPMENT
REPUBLIC OF SINGAPORE

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INTRODUCTION

The importance of mushroom in the food industry has long been recognised as mushroom is both a delicacy and a high protein vegetable food. The consumption of mushroom is universal. Various types of edible mushroom are being cultivated throughout the world. The more popular types of mushrooms cultivated are the button mushroom *(Agaricus spp.)* followed by Shiitake mushroom *(Lentinus edodes)* and the straw mushroom *(Volvariella volvaceae)*.

While a large proportion of the mushroom is consumed in the dried and canned forms, there is an increasing demand for fresh mushroom. In Singapore, the straw mushroom, the abalone and the oyster mushrooms *(Pleurotus spp.)* and more lately the Shiitake mushroom are being consumed in greater quantities in the fresh forms.

Research in edible mushroom cultivation in Singapore was initiated by the Primary Production Department as far back as 1970. At that time, straw mushroom was the only mushroom variety being cultivated. Over the years, the Department has experimented with other varieties of edible mushrooms and has successfully introduced these for cultivation in Singapore. The Department has also been instrumental in experimenting with a wider range of agricultural waste materials as substrates for mushroom cultivation. The use of banana leaves and rice straw has been replaced by other agricultural wastes such as raw cotton waste and sawdust. These have yielded good results. The work of the Department has generated a great deal of interest amongst farmers and the general public. Consequence to this, the Department has organised a number of training courses for the farmers and the general public. Mushroom cultivation in Singapore has now attained increasing popularity amongst the small growers and hobbyists as well as the larger commercial farms which have recently been set up.

The purpose of this booklet is to meet the increasing interest in mushroom cultivation. It is hoped that the booklet will provide the necessary answers to the large number of enquires which have been directed to the Department. While emphasis is focussed on the tropical types of mushroom which are suitable for local production, the booklet also covers the cultivation techniques of other species of edible mushroom such as the black jelly fungi *(Auricularia spp.)*, the white jelly fungi *(Tremella fusiformis)*, the Ling Zhi *(Ganoderma lucidum)* and the Shiitake mushroom.

Part I
PURE CULTURE SPAWN PRODUCTION

Mushroom spawn is an essential input in mushroom production apart from the basic raw materials and chemicals required. The quality of mushroom spawn will definitely affect the yield performance of the mushroom. The spawn is a pure mycelial culture growing in a suitable substrate, such as wheat grains, rice husk, cotton wastes, or sawdust. The procedures for producing mushroom spawn are outlined as follows: (A) Pure mycelial culture preparation (B) Fresh spawn preparation (C) A guide to selection of good mushroom spawn.

(A) Pure mycelial culture preparation

Pure fungal mycelia can be obtained by culturing the tissue of a mushroom fruit body in a suitable agar medium such as Potato Dextrose Agar or Tomato Dextrose Agar or Apple Agar (Appendix 1). 5-10% Chlorox or 70% alcohol is used for surface disinfection of the fruit body before it is cut into tiny pieces (about 2 mm) with a sterilized scalpel. A piece of this tissue is then cleaned with steriled water and placed onto a solidified agar plate under asceptic conditions. The plate is kept under room temperature (28° – 30° C) for mycelial development. Pure mycelia can be seen growing outward from each piece of mushroom tissue within 3-4 days. The rate of mycelial development varies with different types of mushroom.

Alternatively, pure mycelia can also be prepared and cultured from spores collected from spore print. Some basic knowledge in bacteriological techniques is required in order to obtain a pure mycelial culture.

(B) Fresh spawn preparation

"Spawn" is planting material from which pure mycelia obtain their nutrients. It can be compared to the seed used in vegetable growing. The substrate for spawn making can be obtained from a variety of materials. The availability and cost of the materials are the major factors to be considered when deciding on which material is to be used for a large scale commercial production of spawn. Rice straw, rice hull, rice bran, wheat straw, wheat grains, cotton waste and sawdust are some of the common materials for spawn making. In Singapore, raw cotton waste, sawdust, rice bran, calcium carbonate, and wheat grains are the basic ingredients easily available locally for mushroom spawn making.

The procedures for spawn making are briefly described as follows: The raw cotton waste is first wetted with water before mixing with other ingredients such as rice bran and calcium carbonate. The final substrate is adjusted to the required pH value and moisture content. It is then filled into bottles or polypropylene (P.P.) bags. The P.P. bags should be able to withstand high temperature and pressure. There are PP bags speciality made for the mushroom production industry. These P.P. bags are fixed with plastic necks that come with or without caps, and can be easily closed with cotton plugs (Fig. 3). The bottles or the P.P. bags filled with the substrate are transferred into an autoclave for sterilization at 1.1 kg/cm^2 (15 lb/in^2) for 60 minutes. When cooled, each bottle or bag is inoculated with a piece of agar containing fungal (mushroom) mycelia, cultured as in (A). Inoculation work is carried out in a clean cabinet, or a laminar flow cabinet. Pure mycelia will spread from surface downwards and sidewards to the bottom of the bottle or P.P. bag. If grain spawns are being prepared, periodic shaking of the bottle will speed up the spread of the mycelia within the grains. Time taken for the mycelia to spread completely over the substrate will depend on the type or genus of mushroom used, size and quantity of the substrate and the room temperature where the spawns are being held for mycelial development. When the mycelia reach the bottom of the bottle or P.P. bag, the spawn is ready for use. A diagrammatic summary of the spawn making process is given in Fig. 1.

The quality of a good mushroom spawn is mainly determined by the genetic factors of the strain. Generally, vigorous growth, early production and high yields of good quality mushrooms are the desired characters that growers look for. As specialised knowledge is required for the production of good quality spawn, growers are urged to purchase their spawns from a reliable spawn-maker in order to ensure that they may sustain high rate of yield production of mushroom for supply to the market.

(C) A guide to selection of good mushroom spawn

For easy reference, some guidelines to the selection of a high quality, vigorous growing fresh mushroom spawn are as listed below:

a) A high density of mycelia is present in the spawn substrate.

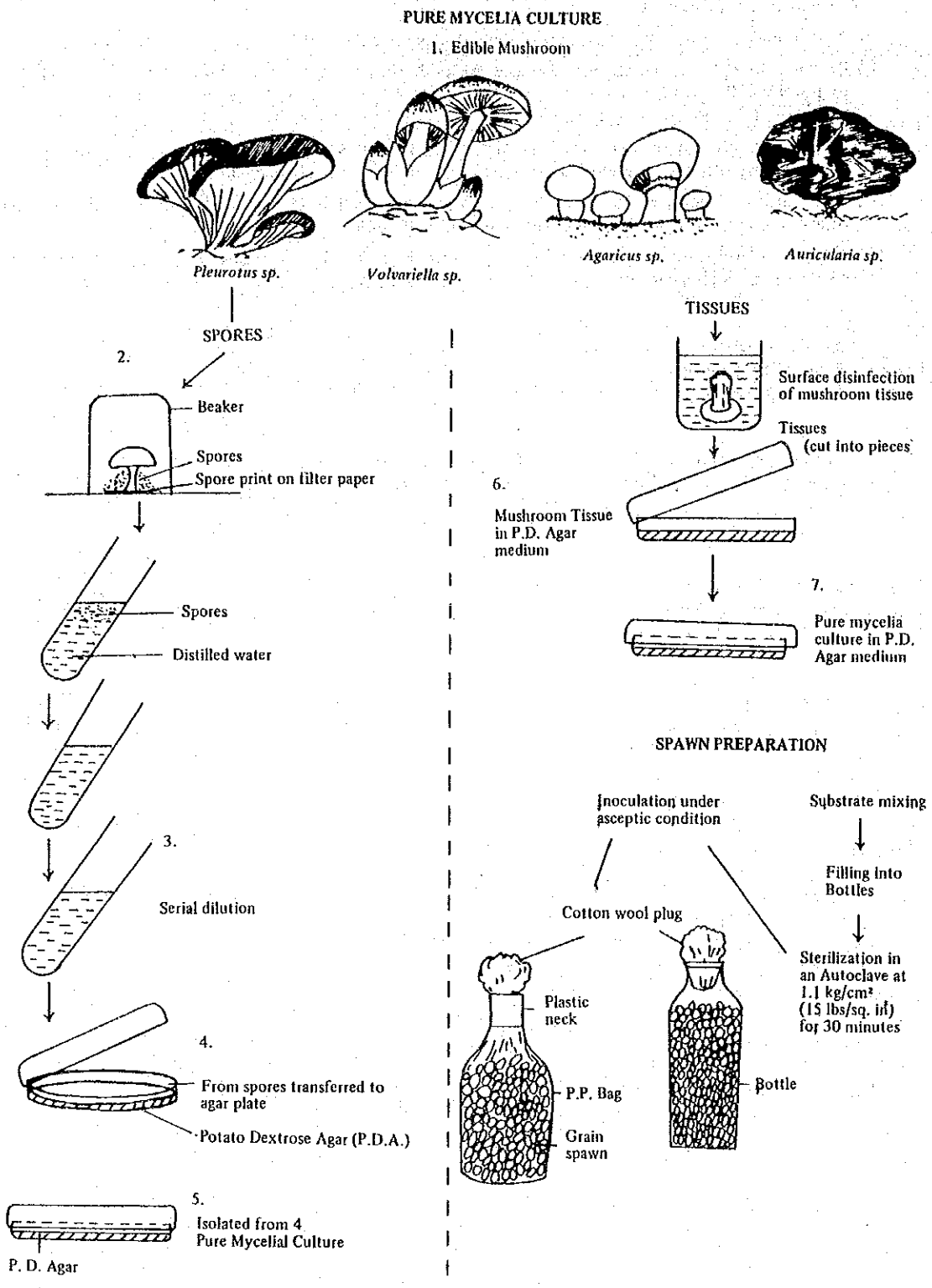
b) Brown coloration in the spawn generally indicates that the spawn may be overdue. It is advisable to purchase the mushroom spawn only when it is required so as to avoid prolonged storage and consequent deterioration of the spawn.

c) When slimy growth or sour smell are detected, it indicates the mushroom spawn is being contaminated by other undesirable micro-organisms, such as bacteria or yeast.

d) If greenish or black patches or spots are detected in the spawn, it indicates the presence of other fungal contaminants such as *Aspergillus sp.* and *Penicillium sp.*

e) Thermal death point of mushroom spawn is rather critical during transportation therefore a cool environment is required during transporation to avoid over-heating and death of the spawn.

Fig. 1 Diagrammatic summary for mushroom spawn-making process under asceptic conditions.



Part II
CULTIVATION TECHNIQUES OF EDIBLE MUSHROOM IN SINGAPORE

1. Straw Mushroom (*Volvariella volvaceae*)

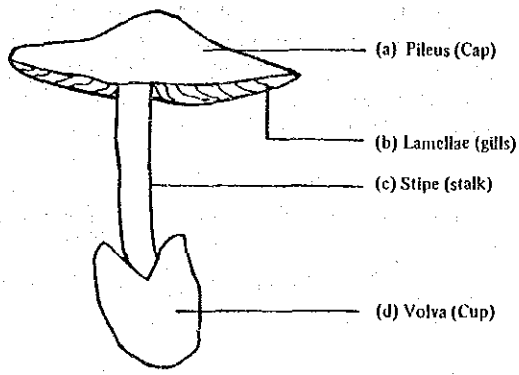
Straw mushroom also known as Chinese Mushroom (Chang 1972) is an edible fungus of the tropics and sub-tropics. Its scientific name is *Volvariella volvaceae*. It originated from Southern China and later was introduced to South East Asia (Chang 1972). The fungus belongs to the lower group of plants in the plant kingdom. It has no chlorophyll therefore it cannot make its own food. It is a saprophyte, which has to depend on nutrients of other fibrous materials for its own growth. Being a tropical fungus, high temperature and high humidity are essential requirements for its growth and fruiting development. Hence, the humid tropical environment is the most suitable place for the commercial production of straw mushroom continuously throughout the year.

A. Morphology

The fruit bodies (mushrooms) are the main part of the fungus and are formed by a group of mycelia. They are exposed to the surface of the growing substrates. The vegetative hyphae are mainly embedded inside the substrate. At the mature stage, (Fig. 2) the whole structure of the fully-opened mushroom can be divided into the following parts:

a) Pileus (cap) b) Lamellae (gills) c) Stipe (stalk) d) Volva (cup) e) Basidiospores (spores)

Fig. 2 Diagram showing the various parts of mature straw mushroom



a) The Pileus (Cap) – This is the umbrella-shaped and circular portion. Its margin is entire and has a smooth surface. The upper surface is dark grey in colour at the centre and light grey near the margin. Its diameter ranges from 6 to 10 cm. The size varies with different strains, and can also be affected by nutritional and environmental factors.

b) The Lamellae (Gills) – These are thin flat structures under the surface of the pileus. The numbers range from 280 to 380 pieces, radiating from the centre outwards. When young they are white in colour gradually turning to pink as the gills grow older and finally they turn dark brown in colour. These gills produce numerous spores.

c) The Stipes (Stalks) – This is the stalk which is attached to the centre of the lower surface of the lower surface of the pileus. At the base of the stipe is the volva. The stipe is white, fleshy and without an annulus. At the young stage, the stipe is short and stout. Its final length varies from 3-15 cm and its diameter from 0.5 – 1.5 cm depending on the size of pileus.

d) The Volva (Cup) – The volva is the remnants of the universal veil which encloses the whole structure of the young mushroom before maturity. It is a thin piece of interwoven hyphae at the bulbous base of the stipe. It is fleshy, light brown and cup-shaped with an uneven margin.

e) Basidiospores – These are spores growing at the tips of sterigmata of the basidia and are called basidiospores. These are produced within the lamellae. A spore has an average length of 7 – 9 μ (micron) and the width of the ends measures from 5 – 6 μ at the wide end to 3 – 4 μ at the narrow end (Chang 1972). The spores germinate and develop into primary mycelia which are septate and turn brownish when old. These mycelia may fuse and exchange nuclear materials to form the secondary mycelia which will subsequently aggregate and form pinhead fruit bodies. The young pinheads eventually develop into mushrooms.

B. Environmental Factors required for Growth and Fruiting

The following factors will affect the growth and fruiting of straw mushroom fungi.

a) Temperature

The mycelia of straw mushroom fungi grow well within a temperature range of 30° – 37°C. The optimal temperature for growth is 34°C. However, fruit bodies are formed at the temperature range of 28° – 33°C. The daily air temperature in Singapore is around this range, it is therefore most favorable for straw mushroom production throughout the year.

b) Relative Humidity

The mycelia will grow well with a relative humidity of 80 – 90% Mycelial growth and fruitification will be impeded when the relative humidity drops below 60%. If the relative humidity is too high, the young fruit bodies may easily rot and become diseased.

c) Ventilation

Ventilation is considered to be essential for mycelial growth and fruit development. Ventilation is not required 3 – 4 days after spawning. However, when young fruiting bodies first appear on the substrate, proper ventilation is essential for producing good quality straw mushroom. An accumulation of carbon dioxide will inhibit mycelia growth and fructification. Fresh air (oxygen) is required during fruiting period. A motor blower can be used to assist in the air exchange and to regulate ventilation.

d) pH value and moisture content of growing substrate

The pH value of substrate for straw mushroom growth should be within the range of 4 – 8. The optimal pH is around 7.

The moisture content of the substrate should be between 70 – 80%.

e) Light

A weakly diffused light is necessary for healthy fructification. Strong or direct sunlight would adversely affect the fruiting bodies and the foumation of mushroom.

The optimal light intensity for straw mushroom growth was found to be 500 lux illumination for 12 hours (Chang 1972). It has also been confirmed that an appreciable quantity of light is required for initiation of fruit bodies (San Antonio 1972). The light intensity in a polyethylene house varies from 50 lux to 100 lux and this is found to be suitable for the fruiting of straw mushroom.

C. Mushroom Growing House and Other Facilities

Straw mushroom cultivation under open field conditions is shown to be prone to pest and disease infection and is subjected to drastic environmental changes. Therefore, it is essential to cultivate straw mushrooms under indoor conditions. A polyethylene (P.E.) mushroom growing house with asbestos roofing and cement floor is found to be suitable under tropical conditions. Fig. 4. shows a simple mushroom house recommended for commercial scale cultivation. A sketch and specifications of the P.E. house are given in Appendix 2 to 5.

A motor blower is installed outside the P.E. house for the purpose of ventilation. Polystyrene foam is used for lining the asbestos roofing so as to provide better insulation against tropical heat. The surrounding four sides of the house are covered with polyethylene sheet or P.V.C. sheet.

Windows are provided on the sides of the house to provide additional control of aeration whenever required or after chemical fumigation of the growing house.

In order to maximise the use of the growing space, multi-tiered shelf system is recommended (Appendix 3 & 5) There are 7 tiers in one shelf. Two shelves with one ventilation duct in the upper central area are ideal for operational ventilation purposes. The growing substrate is disinfected by heat treatment (pasteurization) with steam before spawning. A steam generator is used for supplying steam into the mushroom house. The growing house should be installed with steam ducts connected to a steam generator. For large scale commercial production, the pasteurization of growing substrate before spawning is an important process so as to prevent and minimize the risk of crop failure.

D. Cultivation Technique

a) Substrate and Other Ingredients

Padi straw mushroom is traditionally grown on rice straw. However, recent developments has shown that it can be grown on many other types of fibrous materials, such as banana leaves, raw cotton wastes, oil palm pericarp wastes, bagasse and dried water hyacinth stem and leaves. From the reported yield results, raw cotton wastes from spinning mills is the most suitable growing materials for straw mushroom production in Singapore (Leong *et al.*, 1978).

The cultivation techniques of using cotton waste as substrate are described as follows: Raw cotton waste is first added with water and stepped on until the material is evenly wetted to about 70% of moisture content. 5% (based on dry wt. of cotton waste) of rice bran and 5% of calcium carbonate (Agricultural lime) is spreaded onto the surface of the cotton waste while soaking process is in progress. The well soaked cotton waste is then loosened, split up into small pieces and stacked up into a semi-cylindrical heap or ridge bed on a mutli-tiered wooden shelf. The height of the ridge bed should be about 25 – 30 cm so that the heat within the bed could be better conserved. For large scale commercial production, the process or at least part of the process should be mechanized in order to cut down production cost.

b) Pasteurization of Substrate

The quality of different grades of the raw cotton waste varies. Therefore, in order to promote the good growth of mushroom mycelia on the substrate, stream treatment is required to disinfect and clean up the growing substrate before spawning. It is recommended that the substrate should be pasteurized at 60°C for 3 hours before inoculation. This can be carried out by introducing steam into the P.E. mushroom house after all the beds have been stacked with substrate.

Alternatively, in a small scale cultivation, it is recommended that a 2% formalin solution be lightly sprayed onto the bed soon after spawning. This is to eliminate the potential development of other undesirable fungi on the surface of cotton waste.

c) Spawning

After pasteurization of the substrate, the temperature of the bed is allowed to cool down gradually. Spawning is done while the bed temperature drops to about 32 °C. Approximate 3 – 4% (i.e. 3 – 4 kg) of fresh spawn is required for every 100 kg of dry cotton waste substrate. In order to cover the whole bed with spawn material, the spawn is divided into thumb-sized pieces and is inoculated into the cotton substrate by placing them at the depth of 2 – 5 cm and about 15 – 25 cm apart.

d) Management of Mushroom Crop

The room temperature should be maintained at about 30 °C. The relative humidity of the growing house should be kept between 85 – 90%. Spraying of water is essential so as to maintain the bed surface moist. If the raw cotton waste substrate is used, watering is not required for the first few days after spawning. As soon as the pinhead primodia appear, watering should

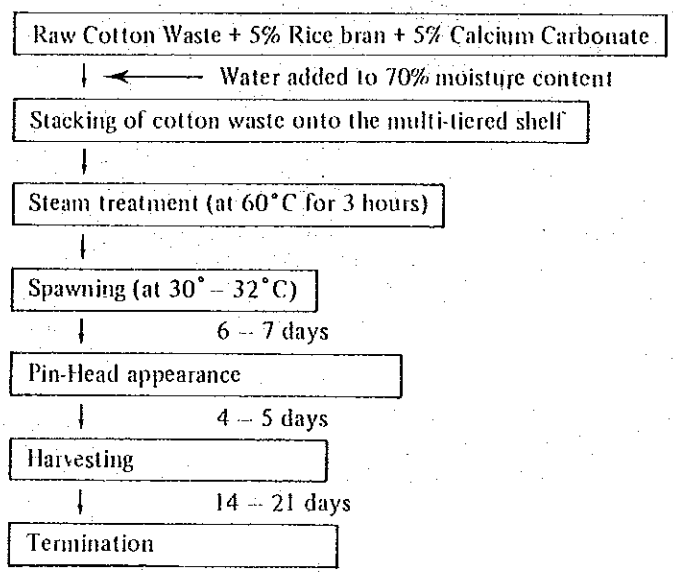
be carried out by using fine spraying nozzles. This is to prevent damaging the mycelia and the young fruit bodies and to avoid over watering. When young pinheads are formed, ventilation should be provided. This can be controlled and regulated through the use of a motor blower, particularly during the warm afternoons from 12 noon to 4 p.m. (Fig. 6) The exchange of fresh air should be controlled in such a manner that it would not affect drastically the room temperature and relative humidity of the growing house.

The culture bed should be checked daily for mycelial development. Clear up foreign fungal contaminants if any. White mycelial growth will appear on the surface of the bed within 3 – 4 days, while young pinhead primodia generally will form in 6 – 7 days after spawning.

e) Harvesting

Straw mushrooms are usually picked at the button or egg stage (Fig. 7) when the veils are still intact. Owing to the rapid development of the fruit bodies (mushrooms), harvesting is generally done twice a day. It is recommended that the first harvest in the day should be done in the very early hours when the weather is still cool and the temperature is low. In an exceptional good flush, an extra harvest may be required to ensure all the mature and marketable quality mushrooms are picked in time. This is because straw mushrooms, if not picked in time, will "open" up, rupturing their veils and become second grade in term of market value. Harvesting period should extend to 2 – 3 weeks with 2 or 3 flushes before the termination of the crop. The growing room should be well cleaned before putting in new growing substrate. The process of straw mushroom cultivation is summarised in Table 1.1.

TABLE 1.1 Flow Chart of Straw Mushroom Cultivation



f) Yield of Straw Mushroom

The yield of straw mushroom is measured in terms of percentage (%). This value is obtained by dividing by the weight of fresh mushroom by the dry weight of substrate material. The quality of substrate materials, strains of mushroom spawn and cultural practices often cause the fluctuations in mushroom yield. Under local conditions, using raw cotton waste as substrate, an average yield of about 20 – 28% can be obtained. However, a yield as high as 45% has also been obtained under very favourable conditions. Yield records of straw mushroom on different agricultural waste materials are listed in Table 1.2 for easy reference.

TABLE 1.2 Straw Mushroom Yield obtained from Different Materials

(a) INDOOR CULTIVATION

Substrate	Yield (%)	Range (%)	References
Banana Leaves	11.2	9.9–12.5	Leong P.C., T.A. Yong & S.E. Chua (1978) (SINGAPORE)
Strawrope packing	18.1	12.2–23.3	
Raw Cotton Waste	20.5	13.9–29.3	
Rice Straw	21.6		Hu *et al.*, (1974) (TAIWAN)
Raw Cotton Waste	45.2	–	
Bagasse	12.4	–	
Raw Cotton Waste + Rice Straw	27.0	–	
Raw Cotton Waste	25 – 35	25.0–35.0	Chang S.T. (1974) (HONG KONG)
Tobacco Mid-rib	1.5 kg/Box	–	Tolentino (1981) (PHILLIPINES)
Rice Straw	14.5		Ho 1972 (TAIWAN)
Oil Palm Pericarp waste	2 – 11		Leong P.C. & T.A. Yong (Unpublished data)

(b) FIELD CULTIVATION

Substrate	Yield (%)	Range (%)	References
Rice Straw	4.5	–	Jalavichavana 1950
Rice Straw	–	6.8–7.3	Chang S.T. (1965)
Rice Straw	4.7	–	Chen & Graham (1973)
Oil Palm Pericarp Waste	1.7	1.1–2.6	

g) Storage and Marketing

Fresh straw mushroom is highly perishable and the quality will deteriorate rapidly under the hot and humid conditions of the tropics. Fresh straw mushrooms when kept in a refrigerator (10°– 15° C), the quality will remain good for one to two days. After which it will turn dark brown in colour, become watery and emit strong odours with prolonged storage. If fresh mushroom is not consumed on the same day of purchase, it is recommended that the mushrooms should be cleaned and parboiled for 3 – 10 minutes in dilute brine (1% salt water) before storing in the refrigerator.

Mushroom growers in Singapore usually deliver their fresh mushrooms to the market or restaurants early in the morning as soon as they are harvested. This will ensure that the mushrooms remain fresh and therefore fetch a higher price.

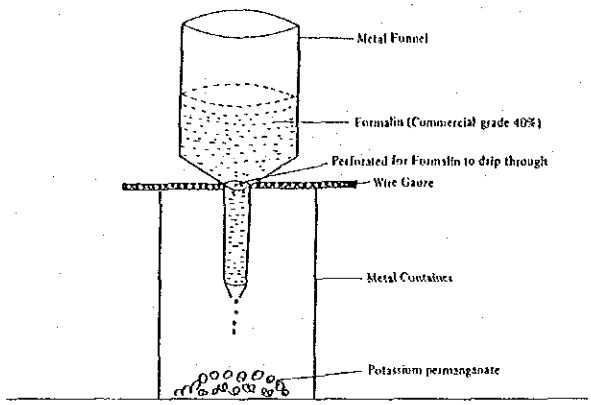
E. Control of Pests and Diseases

A mushroom growing house should be kept clean at all times. This is to ensure and minimise the risk of environmental contamination within the growing house. Before a new crop is put in for

production, fumigation of the growing house with Formalin/Potassium permanganate is recommended. The procedure is as follows:

a) A fumigating container is used for holding the required amount of Potassium permanganate. A cone-shaped funnel with small holes is then allowed to sit on top of the fumigating container over a piece of wire guaze (Fig. 8) The required amount of formalin is poured into the funnel which allows the formalin to drip slowly into the container in to which Potassium permanganate was placed. As a result of the chemical reaction, formaldehyde fumes will be produced. The fumes will fill the growing house and at the same time penetrate all the crevices within the shelves. The mushroom house is kept closed for approximate 12 hours or overnight.

Fig. 8 A simple set up of formalin fumigation.



b) 40 ml formalin solution (40% commercial grade) and 20 g of Potassium permanganate are recommended for every 3 cubic metre of space. When the fumigation is completed, the blower is turned on for air circulation and ventilation.

Fumigation of the growing house after the completion of each growing cycle will keep the growing area clean and hygienic. This will eliminate pests and diseases which might be carried over from the earlier crop.

F. Common Pests, Diseases and Competitors

A list of common pests, diseases and competitors is given below:

a) *Coprinus spp* (Fig 9)

The most common competitors to straw mushroom fungi for nutrients in the growing substrate are the *Coprinus spp.*, such as *C. comatus, C. cinereus* etc. which are heat tolerant fungi. When the substrate favours the growth of *Coprinus spp.*, *Coprinus* fungi will appear early and the yield of straw mushrooms will be adversely affected. These weed fungi will subsequently deliquese into black inky liquid which drips from the disintegrating cap. This is one of the characteristics that differentiates *Coprinus* from *Volvariella* in the same bed.

b) White Mould *(Monilia sp.)*

Occasionally, the substrate will be contaminated by a fast-growing white mould, *Monilia* species. It develops swiftly and covers the entire bed within 2 – 3 days causing a sharp rise in bed temperature. The growth of *Volvariella* mycelia will then be greatly suppressed or killed. In cases where young fruit bodies of *Volvariella* have been formed, the white mould will attack these fruit bodies causing soft rot of mushrooms. Early detection of these white mould is very important so as to prevent a total crop failure. Fungicides such as Thiram or Mancozeb may be sprayed onto the affected beds and will help to stop the spread of the white mould. In severe cases, it is recommended that the substrate be removed and replaced with fresh substrate.

c) *Sclerotium rolfsii*

Sclerotium rolfsii is a white fungus which develops fairly rapidly on rice straw substrate. It forms sclerotia on the straw bed. When detected, the affected portions should be removed. A fungicide spray of benomyl or mancozeb can then be applied. This will cease the spread of this fungus.

d) Other fungal contaminants

Aspergillus, Penicillium, Trichoderma, Neurospora and other moulds may sometimes occur on the substrate. They can be eliminated with fungicidel sprays.

e) Bacteria and Nematodes

Soft rot of young fruit bodies may be caused by over watering and improper ventilation. Very often nematodes and bacteria are found associated with these rots. Proper watering and ventilation of the growing bed will minimize the problem.

f) Mushroom flies and Mites

Mushroom flies and mites are commonly found on mushroom beds at the later stage of cropping. Fumigation and disinfection of the entire growing house after each crop will eliminate the sources of infection. But reinfestation of the substrate from surrounding areas will occur if a grower does not keep his farm clean and in a hygienic condition. It is fairly difficult to eliminate the mites or flies once they appear at the early stage during the spawn running period. Care must be taken when applying pesticide sprays as they will also affect the development of *Volvoriella* and may cause the fresh mushrooms unfit for consumption and marketing.

2. *Pleurotus* Mushroom

a) *P. cystidiosus*, Abalone Mushroom
b) *P. florida*, White Oyster Mushroom
c) *P. sajor-caju*, Grey Oyster Mushroom
d) *P. flabellatus*, Pink Oyster Mushroom

Several species of *Pleurotus* mushrooms have been successfully cultivated in Singapore by using raw cotton waste substrate (Leong 1982). Among which abalone mushrooms, *P. cystidiosus var. abolonus* are the most popular and of the best quality. The rest of the species are grouped under oyster mushrooms. *Pleurotus* mushrooms originally grow in the wild on dead wood or decayed compost. These mushrooms develop in groups overlapping one another in tiers. Those species which show high yield, good flavour and excellent quality for consumption are selected for growing in the mushroom house. These commercially produced mushrooms are marketed either fresh or in canned form.

A. Morphology

The *Pleurotus* fruit bodies vary in shape, size and colour. Their development can be affected by different environmental conditions. A brief description of the characteristic of each type of the oyster *(Pleurotus)* mushrooms is given below.

a) *Pleurotus florida* (White Oyster Mushroom) (Fig. 10)

The pileus (cap) is shell-like in shape. Sometimes it is spatula or tongue-like. The colour varies from milky white to light yellow. A mature pileus has a size ranging from 3 – 12 cm. The white lamellae (gills) are on the underside of the pileus, being decurrent. The stipe (stalk) is short and stout, emerging from the side of the cotton blocks. The spores being hyaline measure 8 – 12 μ(micron) in length x 3 – 4 μ in thickness. The spore print is white. When matured, they are discharged in numerous numbers and fall onto the shelf surface as a faint smoke visible to naked eyes. This variety can be easily cultivated and can be used for home growing.

b) *Pleurotus flabellatus* (Pink Oyster Mushrooms) (Fig 11)

This strain is characterised by the pink colour of the young fruit bodies. As the pinhead primodia develop, they become pink in colour. The pink colour fades into pinkish white, as they develop further. At the mature stage, the open pileus turns white. It is less fleshy and the texture is more leathery. It is a high yielding variety and can be easily cultivated. The pinkish colour of the pileus is rather attractive and can also be used for ornamental display.

c) *Pleurotus sajor-caju* (Fig. 12)

P. sajor-caju is grey in colour. It has a good taste and has a better texture than *P. florida* and *P. flabellatus*. The mycelia will develop and fruit well in a cotton waste substrate under tropical conditions.

d) *Pleurotus cystidiosus* (Abalone Mushroom) (Fig 13)

The abalone mushrooms which are commercially grown here can fruit well under tropical conditions at temperatures between 28° - 32°C. They can be successfully grown either with raw cotton waste or sawdust or with a mixture of both. The fleshy pileus (cap) of this mushroom appears grey to dark grey in colour, with a size measuring about 3 – 15 cm in diameter. But the underneath of the cap is white in colour. There is a slight depression in the centre. The lamellae (gills), being decurrent are broad and creamy white. The stipe is solid and firm. It has a compact texture, with a length varying from 3 to 8 cm and a diameter of 1 – 2 cm. The spore print is a creamy white mass. This is a very popular strain which is readily acceptable by local consumers due to its excellent quality. It has a firm flesh and is delicate in texture.

B. Environment Factors Required For the Growth and Development of *Pleurotus* Mushrooms

a) Temperature

For the development of vigorous mycelia, *Pleurotus florida, P. sajor-caju, P. flabellatus* and *P. cystidiosus* grow very well at cool temperatures of 20° - 25°C. This low temperature promotes the growth of the *Pleurotus* mycelia. For mushroom (fruit bodies) development, the temperature of 28° – 30°C is found to be most suitable for all the species of *Pleurotus* to grow well in Singapore (Leong 80 & 82). It was reported that different temperatures had a significant effect on the growth of Abalone mushrooms and the optimum temperature for cultivation was between 25°C to 30°C. No fruiting bodies were formed below 25°C or above 35°C. Deformation of mushroom was noted at 35°C and 40°C (Cheng 1977).

b) Relative Humidity

High relative humidity is required for the growth of mycelia and the development of the fruit bodies. Generally, the growing room should be maintained at relative humidity of 80 – 85%. When humidity of the room is too low, the development of the pinhead primodia will be impeded and the crop will fail.

c) Light

It has been reported that light intensity produced no significant effect on the growth and the weight of fruiting bodies, but it stimulates the formation of pinhead primodia and the development of fruit bodies (Cheng & Han 1977). The colour of the pileus varies with different degree of light intensity. Abalone mushroom grown under diffused light of a P.E. mushroom house is darker in colour than those grown under higher light intensity. The growing house should be erected away from direct sunlight. Shade plants should be used to cut down the tropical heat. Shrubs can be planted around the shed to provide a cooler environment and to cut out direct sunlight penetrating into the growing house, which may affect adversely the development of the mushroom.

d) Ventilation

Exchange of fresh air in the growing house is an important factor for normal mushroom development. It was observed that ordinary farm houses converted into mushroom growing

houses by lining the four sides with plastic sheet did not provide adequate ventilation for mushroom growth. Under such conditions, pests and diseases on both the fruiting bodies and substrates were severe. Windows with movable plastic sheet perforated with holes will provide ventilation for mushroom development and reduce the incidence of pests and diseases. Ventilation can be controlled and regulated with the installation of a motor blower or an exhaust fan. If this is not available, adequate windows should be provided for this purpose.

e) pH value and moisture content of substrate

Pleurotus mushrooms can grow within the pH value ranging from 5.5 to 7. The growing substrate of a mixture of cotton waste, 5% rice bran and 5% $CaCO_3$, has a pH of 6.5. The moisture content of the growing substrate should be adjusted to about 70% during spawning.

C. Cultivation Techniques

Abalone Mushrooms *(P. cystidiosus)*

a) Basic facilities and equipment

The agricultural waste materials such as raw cotton waste and sawdust are ideal for large scale commercial production of abalone mushrooms. Other materials such as oil plam pericarp waste and straws can also be utilised as alternative substrates for abalone mushroom production. For large scale production, the following basic facilities and equipment are required.

1) Substrate Mixing Machine and Substrate Packing Machine

In a mushroom farm, the production process of the mixing of sawdust, rice bran, calcium carbonate and other ingredients, the filling of substrate into P.P. bags and the packing of substrate can all be done manually. But the production efficiency is low. Special machines designed to carry out these processes are now available. Hence, large quantities of substrate bags can be made within a short period. Consequently much time and manpower can be saved.

2) Steam generator and Retort for Sterilisation

Steam is supplied to a horizontal retort (Fig. 5) for sterilisation by a steam generator. For abalone mushroom production the growing substrates must be sterilised before they can be innoculated. For small scale production a high pressure cooker can be substituted for the retort.

3) Inoculation Cabinet

The laminar flow air cabinet provides a clean area for inoculation work i.e. for transfer of mushroom spawn (seeds) into the sterilised growing substrate contained in a P.P. bag. The laminar flow cabinet will ensure a very high and successful rate of inoculation. Contaminations of the substrate will be kept to a minimum.

4) Spawn-running room

An air-conditioned room at 20° – 25°C is used for keeping all the inoculated or spawned bags for mycelial development. The chilled environment will ensure a uniform and fast growth rate. It has been found under ambient temperature of 28° – 32°C the spawn of the inoculated bags will not spread uniformly and wll run at a much slower rate. This affects not only the schedule but also the yield of the mushroom crop. Therefore an intermediate chilled room is recommended for spawn running under lowland tropical condition.

5) Mushroom Production House

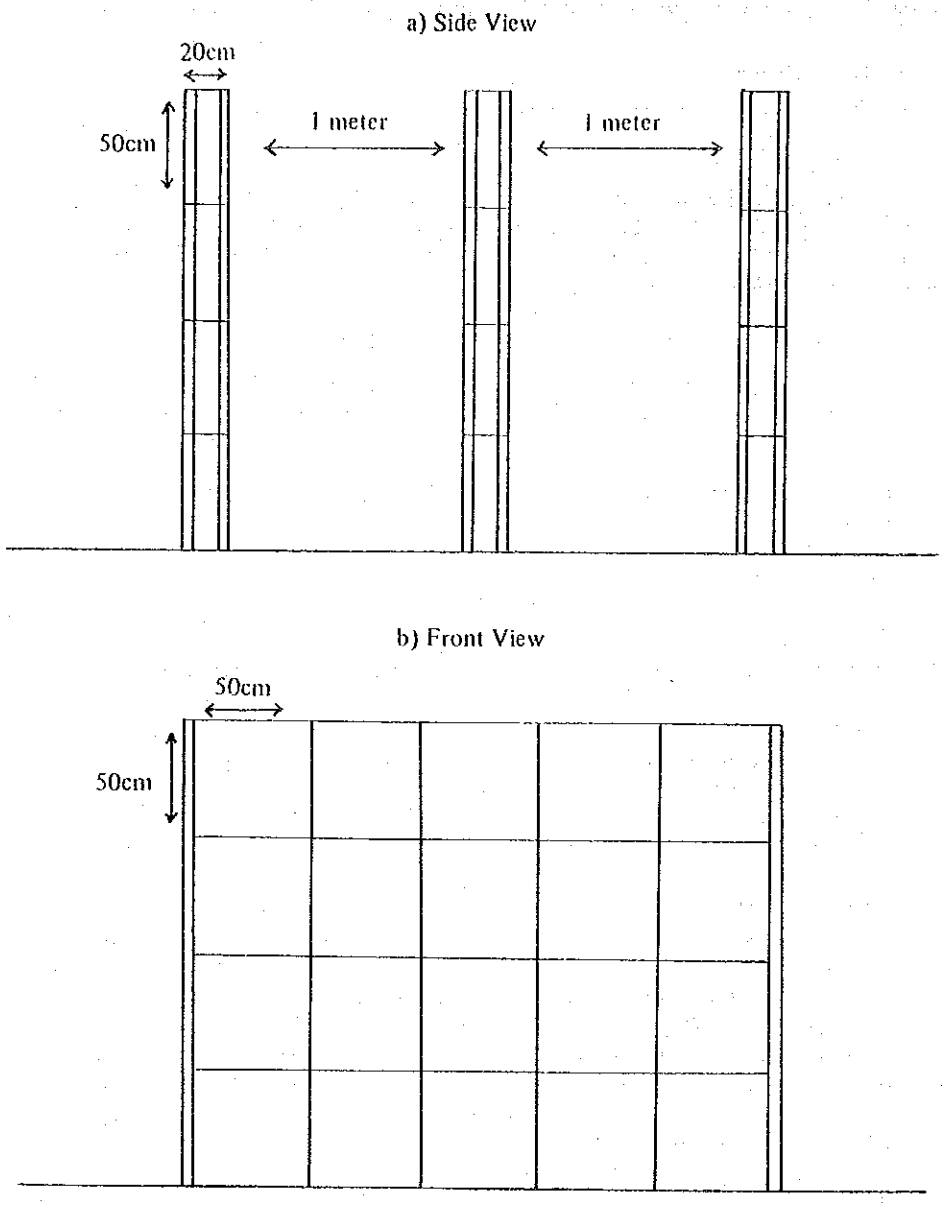
The P.E. house described in an earlier chapter can be used for abalone mushroom production with some modifications. The horizontal shelves should be changed into a vertical racks, for easy operation and management of production as shown in Fig. 14 & 15. Such racks will be able to hold a larger number of spawned bags for fruiting and are also more convenient for harvesting work as workers do not have to search for the mature mushrooms. Automatic water spraying systems can be easily installed between the vertical racks.

b) Growing materials

Wheat straws, rice straws, sawdust and a variety of other cellulose wastes can be used for the cultivation of *Pleurotus* mushrooms. In Singapore, raw cotton wastes and sawdust are used for the production of *Pleurotus florida* and *P. cystidiosus*.

Experimental results showed that rice strawrope and oil plam pericarp waste can also be used as alternative sources of growing material for cultivation.

Fig. 15 A sketch of vertical mushroom rack for abalone mushroom production



c) Method of Cultivation

1) The required amount of raw cotton wastes (20% of substrate wt) is weighed and then wetted with water to about 60% moisture. The wetted cotton wastes is mixed with sawdust (60%), rice bran (15%) and agriculture lime $CaCO_3$(5%). The moisture content of the mixed substrate is finally adjusted to 60%.

2) The substrate is then filled and packed into polypropylene bags by a packing machine (Fig. 16) and each P.P. bag is finally fixed with a plastic neck and cotton plug. Each substrate bag weighs about 1 kilo gram.

3) The substrate bags are transferred to a retort for steam sterilisation at 1.1 kg/cm² for 1 – 2 hours depending on the type of substrate materials used and the sizes of the substrate bags.

4) The steam treated substrate bags are allowed to cool and then inoculated with grain spawn under the aseptic conditions using a laminar flow cabinet.

5) The spawned substrates are kept under a low temperature environment of 20° – 25° C for spawn running.

6) After about 4 weeks, when the mycelia have fully grown and developed, these spawned bags are shifted into the mushroom house for mushroom production. The bags are cut open on the top, and a few slits are made at the side of the polypropylene bags. These bags were placed horizontally on the vertical racks. Each bag is stacked on top of another, as shown in Fig 2.7.

7) The air temperature of the growing room should be maintained at about 28° – 30° C, and relative humidity at 80 – 85%. Daily watering should be carried out at least twice a day. Pinhead primodia will appear in about 4 – 7 days. An automatic water spraying system should be installed for commercial production so that the amount of water and frequency of spraying can be controlled automatically by a time switch.

8) The mushrooms are ready for harvest when the pileus (cap) of the mushroom grows to 4 – 8 cm in diameter or before the pileus turns flat. Harvesting can be done by breaking the cluster of mushrooms at the base by hand or by using a knife.

9) The second flush of mushroom will appear within 2 – 3 weeks. More flushes will be obtained when the conditions are right. Harvesting period can usually be extended to 8 weeks, after which the spent substrate bags should be cleared and discarded.

d) Yield of Abalone Mushroom

Usually a yield of about 15 – 25% based on the wet weight of substrate can be obtained by the above method. Although the brown strain 'Ab1' can give a higher yield, the texture of the mushroom is of inferior quality. A flow chart of Abalone mushroom cultivation is shown in Table 2.1.

Oyster Mushrooms

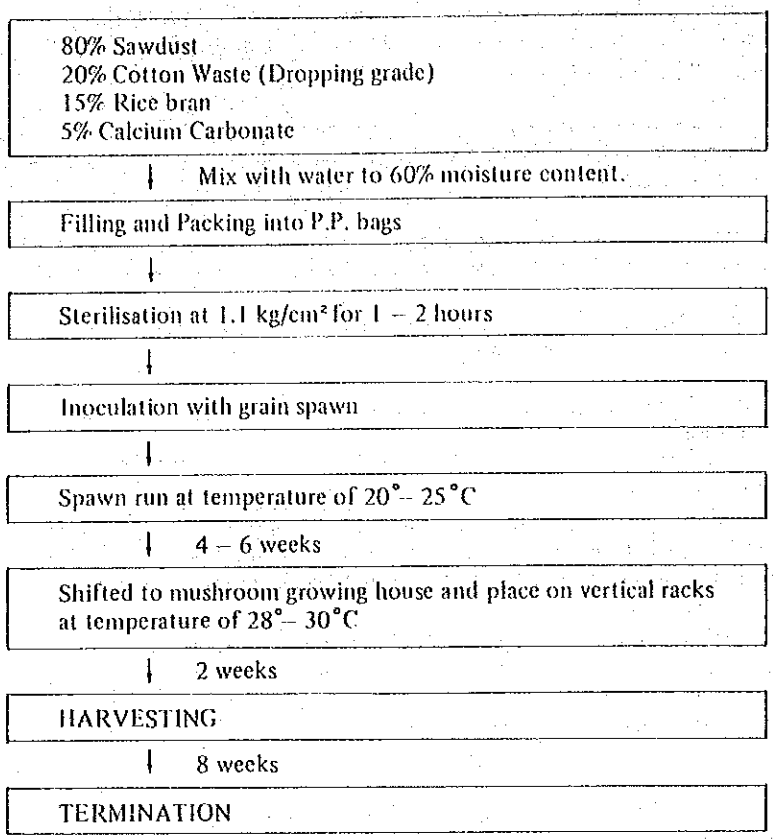
(P. florida, P. sajor-caju, P. flabellatus)

a) Method of Cultivation

The methods of cultivation for the oyster mushrooms are fairly simple and are applicable to all the three strains (Leong 1980). This is because these strains can grow very rapidly and vigorously on the cotton waste substrate even without sterilisation. The mycelia are fully developed before other fungal contaiminants can set in. The methods of cultivation are briefly described as follows:-

1) The undercasing grade of raw cotton waste is used for the production. The cotton waste is first wetted with water to about 70 – 80% of moisture content.

TABLE 2.1: A Flow Chart of Abalone Mushroom Production



2) Rice bran (5% w/w) and calcium carbonate (5% w/w) are then mixed into the cotton waste while the wetting process is in progress.

3) The cotton waste mixture is then loosened and put into a PVC bag which is able to hold 1 kg or 2 kg dry weight of cotton waste.

4) Spawning is done while the filling of cotton waste into the plastic bags is in progress. About 10% by weight of mushroom spawn is used for each block during spawning. The spawn is broken into small pieces which are then inserted into each layer of cotton waste while the block is being made.

5) The spawned plastic blocks are then inverted and placed onto a multi-tiered racks for spawn-run inside a cool room at 20°– 25°C for 3 – 4 weeks. At the end of spawn-run, the mycelia are fully grown. At this time the pinhead primodia may emerge through the perforated holes of the plastic bags.

6) The fully-grown mushroom blocks are shifted to a mushroom growing room where the room temeprature is kept below 30°C and a high relative humidity of 80 – 85% is maintained. The plastic bag is removed and the blocks are than placed on a multi-tiered shelf. The white mycelial blocks are lightly watered 2 – 3 times a day. Within 4 – 7 days various stages of oyster mushrooms will appear on the blocks.

Plate I

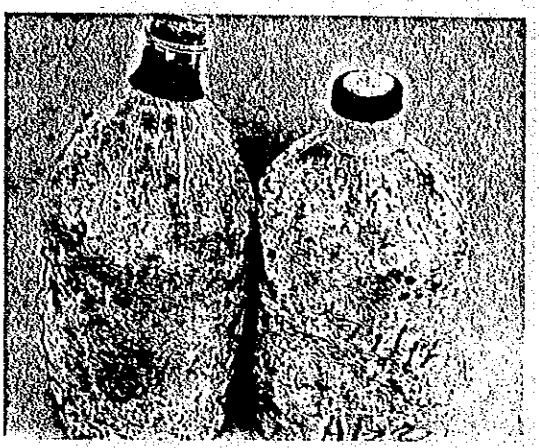


Fig. 3 P.P. bags with plastic necks and cotton plugs

Fig 4 Polyethylene mushroom growing house

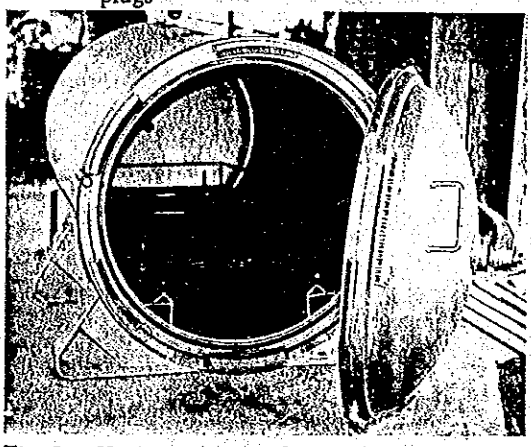


Fig. 5 Horizontal retort for sterilization of mushroom substrate

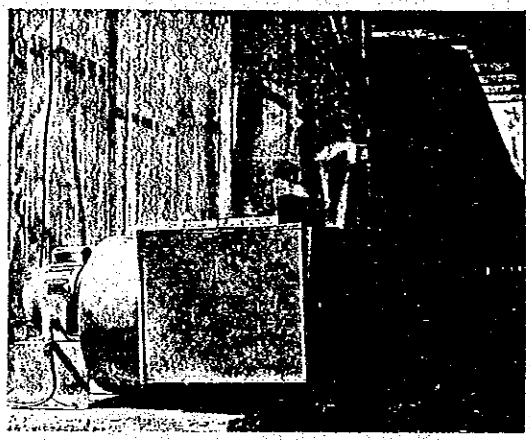


Fig. 6 Motor blower connecting with P.V.C. tubing for ventilation

Fig. 7 Fruiting of straw mushroom on raw cotton waste in multi-tiered shelves

Fig. 9 *Coprinus comatus*, a competitor appears on cotton waste growing bed.

Plate II

Fig. 10 Fruiting of white Oyster Mushroom *(Pleurotus florida)*

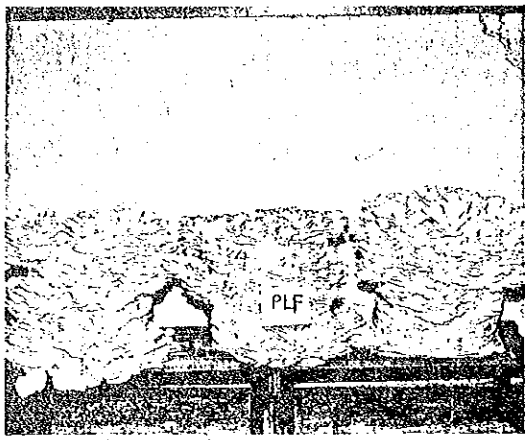


Fig 11 Fruiting of pink Oyster Mushroom *(Pleurotus flabellatus)*

Fig. 12 Fruiting of grey Oyster Mushroom *(Pleurotus sajor-caju)*

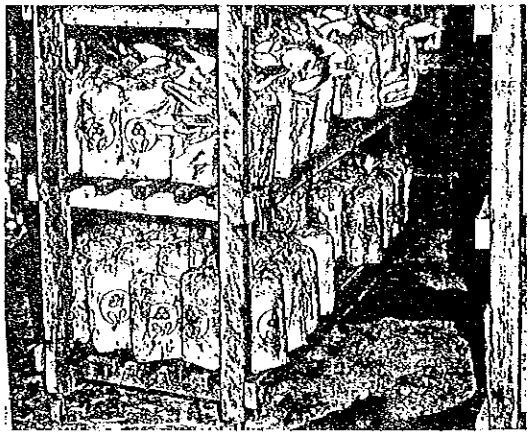


Fig. 13 Fruiting of Abalone Mushroom *(Pleurotus cystidiosus)* on multi-tiered racks

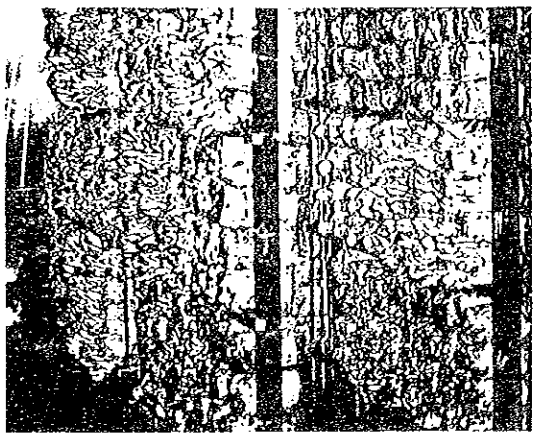


Fig. 14 Vertical wooden rack for intensive cultivation of Abalone Mushroom

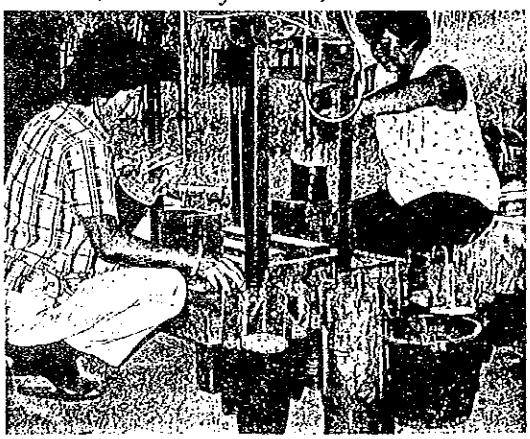


Fig. 16 Packing of mushroom substrate bags by machine

Plate III

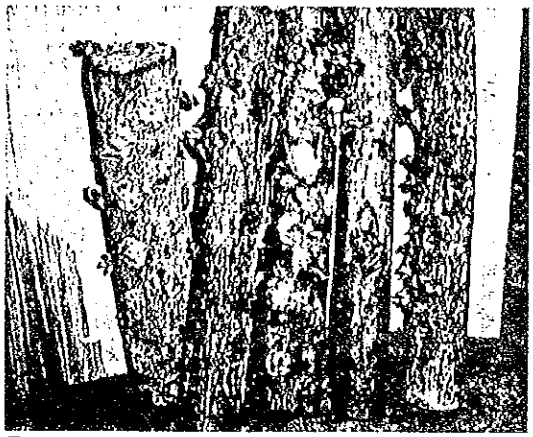


Fig. 17 Fruiting of Black Jelly Fungi *(Auricularia sp.)* on *Acacia* logs

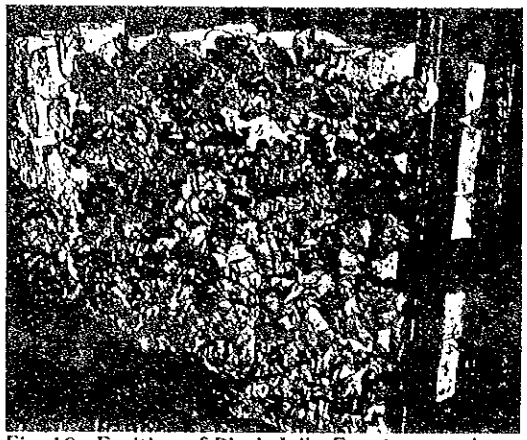


Fig. 18 Fruiting of Black Jelly Fungi on sawdust substrate

Fig. 24 Mushroom growing at home

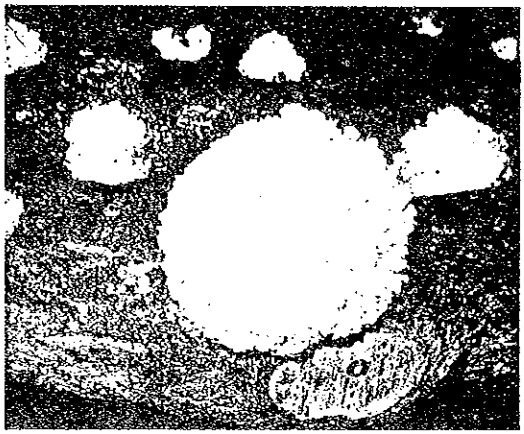


Fig. 25 Fruiting of White Jelly Fungi *(Tremella fusiformis)* on Mango logs

Fig. 26 Fruiting of Ling Zhi *(Ganoderma lucidum)*

Fig. 27 Button Mushroom *(Agaricus bitorquis)* a tropical strain

Plate IV

Fig. 28 Shiitake mushroom *(Lentinus edodes)* growing on sawdust substrate

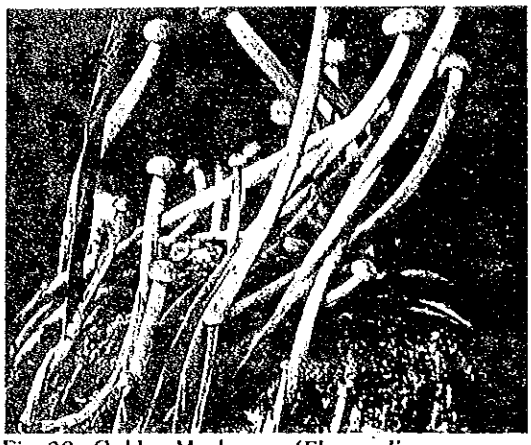


Fig. 29 Golden Mushroom *(Flammulina velutipes)* growing on sawdust substrate

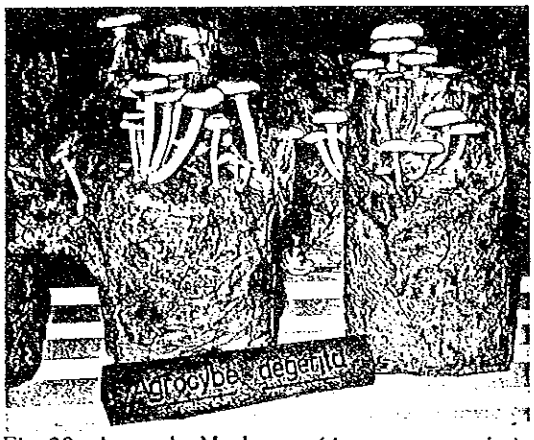


Fig. 30 Agrocybe Mushroom *(Agrocybe aegerita)* growing on sawdust substrate

Fig. 31 Nameko Mushroom *(Pholiota nameko)* growing on sawdust substrate

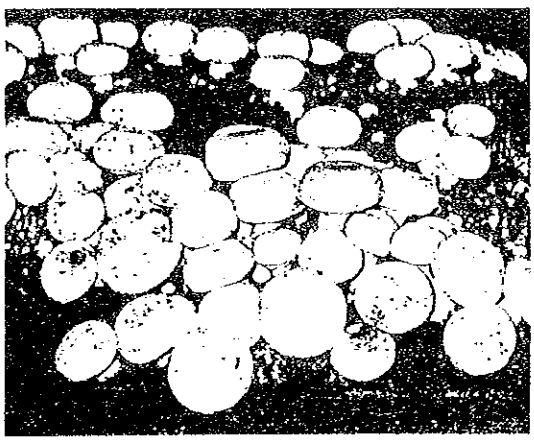
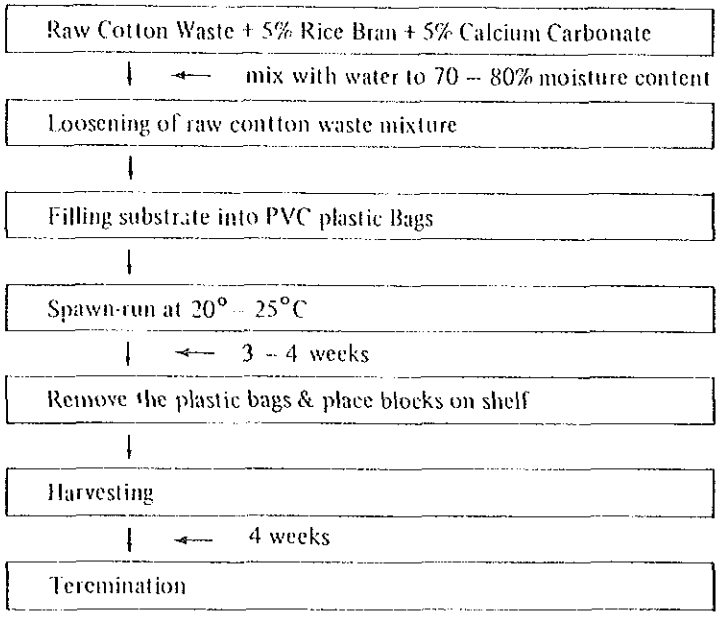


Fig. 32 Button Mushroom *(Agaricus bisporus)* growing on composted cotton substrate

Fig. 33 Oyster Mushroom *(Pleurotus ostreatus)* growing on cotton waste substrate

7) With proper management of the crop, harvesting of mushrooms can be extended to 4 weeks in 2 – 3 flushes. After which, the spent mushroom blocks should be discarded. Table 2.2 shows a flow chart of oyster mushroom cultivation.

TABLE 2.2 A Flow Chart of Oyster Mushroom Cultivation



b) Yield of Oyster Mushrooms

The yield of oyster mushrooms ranges from 40% to over 100% depending on the species of *Pleurotus* and the quality of the raw cotton waste. By using the good quality and long fibre-type of undercasing raw cotton waste a yield as high as 100% or over 100% can be achieved for *P. florida* and *P. flabellatus*. The mean yield from a series of trials on 3 species of *Pleurotus* is shown in Table 2.3. The yield %, or the biological efficiency is computed as the weight of fresh mushroom divided by the weight of the dry substrate.

TABLE 2.3 Yield of *P. florida*, *P. sajor-caju* & *P. flabellatus*

Species	Mean Yield (%)	Range (%)
White Oyster Mushroom *(P. florida)*	79	70 – 115
Grey Oyster Mushroom *(P. sajor-caju)*	51	40 – 64
Pink Oyster Mushroom *(P. flabellatus)*	82	73 – 120

c) Storage and Marketing

Abalone mushrooms and oyster mushrooms can be kept in a refrigerator (5° – 10°C) for 2 – 3 days. If it is not immediately cooled, the *Pleurotus* mushrooms should be parboiled in dilute saline solution (1%) for a few minutes before storing it in a refrigerator. Fresh *Pleurotus* mushrooms are usually sold to restaurants and supermarkets early in the morning.

D. Control of Pests & Diseases in *Pleurotus* mushroom Growing House

The mushroom bags for Abalone mushroom production are sterilized before inoculation. If the hygienic condition of the growing house is properly and strictly maintained, there should be no severe problems of pests and diseases. In the local farms the most frequent fungal contaminant, is the characteristically orange-yellow coloured *Neurospora sp.* It occurs as early as during the spawn-running stage or at the growing house at fruiting stage. Other fungal contaminants, such as *Penicillium, Aspergillus, Trichoderma* etc. are less severe. Bacterial rot due to inadequate ventilation and excessive watering spreads rapidly from one bag to the others.

Prevention is always better than cure. For *Neurospora* contamination, it is recommended that the entire room should be cleaned and fumigated with formalin. All the contaminated bags should be discarded and destroyed away from the farm.

To prevent bacterial rot, it is important to remove the base of the stalks entirety during harvesting, improve the ventilation system and avoid excessive water spraying. At the end of each cycle of production, when the cropping is terminated, the growing room should be thoroughly cleaned and fumigated, before a new production cycle is initiated.

3. Black Jelly Fungi (*Auricularia* species)

Black jelly fungi also known as Jew's ear grow naturally on dead wood. It has been considered as a delicious food by the Chinese for centuries. As the shape of the fruit bodies resemble human ears, so the name in Chinese "Mu-Erh" means "Woody ear or the ear of tree logs". In Singapore, there are a few types of dry "Mu-Erh" sold in the market. "Chuan-Erth" is a more popular species which is produced in Szechuan province in China (Chang & Tu 1978). One species, which is characterised by a rubbery and gelatinous texture is fairly common and cheap in the local market.

A. Morphology

The morphological characteristics of black jelly fungi are always affected by external growing environment. The shape, colour and size of fruit bodies are only the superficial features. Morphological characteristics for classifying this group of fungi are considered to be confusing. Depending on species, the shape of the fruit body (mushroom) varies from oval or shell-shaped to ear-shaped and the colour also varies from yellowish brown to reddish brown. It is jelly-like when fresh. When dry it is yellowish brown to olive brown and is hard. The spores are white and allantoid in shape.

B. Environmental factors required for growth and development of fruit bodies

Black jelly fungi can grow within a temperature range of 12°to 36°C. The optimal temperature is 28°C. (Borromeo 1967; Cheng & Tu 1976; Wu 1976) Under local conditions the spawned sawdust substrate in P.P. bags are first kept at a low temperature of 20°– 28°C for spawn run for 3 – 4 weeks. These are then shifted to mushroom sheds for fruiting at ambient temperature of 28°– 30°C. The other requirements such as high relative humidity and some indirect light are found to be more or less similar to that for abalone mushroom for the growth of mycelia and development of fruit bodies.

C. *Cultivation techniques*

a) Using wood logs

The traditional method of growing *Auricularia* on tree logs is quite simple. The process involves selecting a wood species, drilling holes on the log and inoculating the holes in the log with fresh *Auricularia* spawn. The hold is then sealed with a layer of beewax. After a period of maintenance of 1 – 2 months, *Auricularia* fruit bodies appear on the surface of the log (Fig. 17) Wood logs from *Acacia sp.* or *Hevea sp.* trees can also be used for the growing of black jelly fungi.

b) Using sawdust substrate

A modern method for commercial scale of growing of black jelly fungi is done by the use of P. P. bags. (Fig. 18) The procedures of preparation of substrates in P.P. bags are similar to those described for abalone mushroom. Table 3.1 shows a flow chart of *Auricularia* cultivation.

TABLE 3.1 A Flow Chart of Black Jelly Fungus Cultivation *(Auricularia sp.)*

80% Sawdust + 20% Cotton dropping + 15% Rice bran + 5% Calcium carbonate
↓ mix with water to moisture content of 70%
Filling and Packing into P. P. bags
↓
Autoclave at 1.1 kg/cm² for 1½ hours
↓
Inoculate with mushroom spawn
↓
Spawn run at 20°– 25°C
↓ 3 – 4 weeks
Shifted into mushroom house and stacked on the vertical wooden racks at 28°– 30°C
↓ 2 weeks
Harvesting
↓ 8 weeks
Termination

c) Yield of *Auricularia sp.*, Strain J5

The mean yield of black jelly fungi expressed as the weight of fresh black jelly fungi divided by the wet weight of sawdust substrate, is about 32%, with a range between 21% to 41%. The fresh mushroom if not sold in time can be dried over the air-drying cabinet to prolong the period of storage. This is an advantage in terms of distribution and marketing. There is not much difference between the quality of fresh and dried black jelly fungi.

4. Spawned Blocks of *Pleurotus* Mushrooms and Black Jelly Fungi For Home Growing

In popularising mushroom cultivation a home growing method of *Pleurotus* mushrooms and black jelly fungi has been successfully developed. The spawned mushroom blocks are specially prepared for anybody who is interested to grow their own fresh mushrooms at home, especially for those living in housing flats. In school, these blocks serve as an ideal biological science teaching material for the study of their morphology and life history. Maintenance of these blocks is very simple and no special skill is required for keeping and growing them.

A. Maintenance of the spawned oyster mushroom blocks

When the mycelia in the mushroom blocks have fully grown and completely covered the whole raw cotton waste substrate, the plastic bag should be cut open and removed for fruiting.

These mushroom blocks should be placed in a cool environment that is high in relative humidity and shaded from direct sunlight. Fig. 19 shows the correct way of keeping the relative humidity high at home. The temperature for growing should preferably be below 30°C and not exceeding 32°C. Light spraying of water should be applied 2 – 3 times daily onto the blocks to ensure that the substrate contains adequate moisture. Avoid excessive watering which may cause rotting while fruiting is in progress.

Harvesting

1) Pinheads primodia i.e. the young fruiting bodies will appear in about 3 – 5 days, after the plastic bag is removed. They will grow into various shapes such as shell, spatulas or tougue-shaped. Their colour also varies with different species. It is white to pale yellow in *Pleurotus florida* pinkish red to white in *P. flabellatus* and light grey to grey in *P. sajor-caju*.

2) When the caps grow to about 4 – 6 cm in diameter, or before the caps are flattened, they are ready for harvest. Harvesting can be done by breaking the cluster of mushroom at the base. The 2nd flush or cropping will appear in about 7 – 10 days after the lst flush. Harvesting period can be extended for a period of about 4 weeks after which the blocks should be discarded.

3) An example of an ideal cropping on 1 kg dry-weight cotton substrate and its harvesting schedule *(P. florida)* is shown in Fig 20.

B. Maintenance of the Spawned Abalone Mushroom Bags/or Black Jelly Fungus Bags.

Outlines of the procedures for growing the spawned mushroom bags are given as follows:

1) The top portion of the polypropylene bag is cut open with a razor blade or a pair of scissors and a few slits are made on the sides of the P.P. bag (Fig. 21). The spawned bags should be placed in a cool and high in relative humidity environment as described above. Similarly, light spraying of water should be applied 2 – 3 times daily. Young fruiting bodies will appear in about 4 – 7 days after the P.P. bags are cut open. These young fruiting bodies will grow into marketable sizes within 8 – 12 days. The harvesting procedure is similar to those in oyster mushrooms.

2) Examples of the yield patterns of abalone mushroom *(P. cystidiosus)* and of black jelly fungi (*Auricularia*) are shown in Fig. 22 and Fig. 23 respectively.

Fig. 19 A simple set up for Oyster Mushroom growing at home

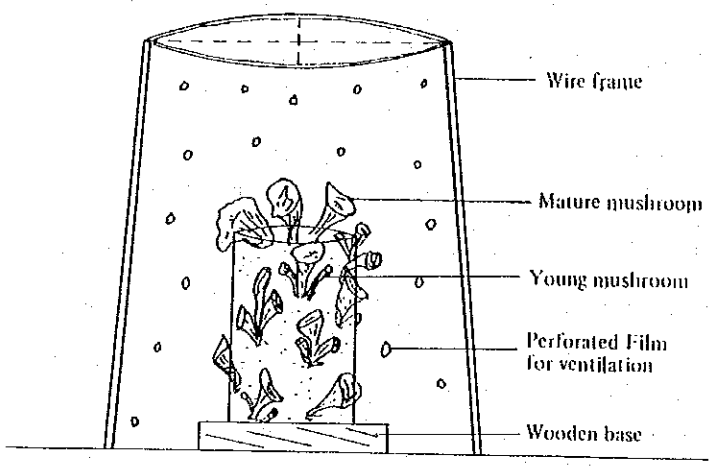


Fig 20. Yield Pattern of a 1-kg (dry wt of substrate) Block of Oyster Mushroom

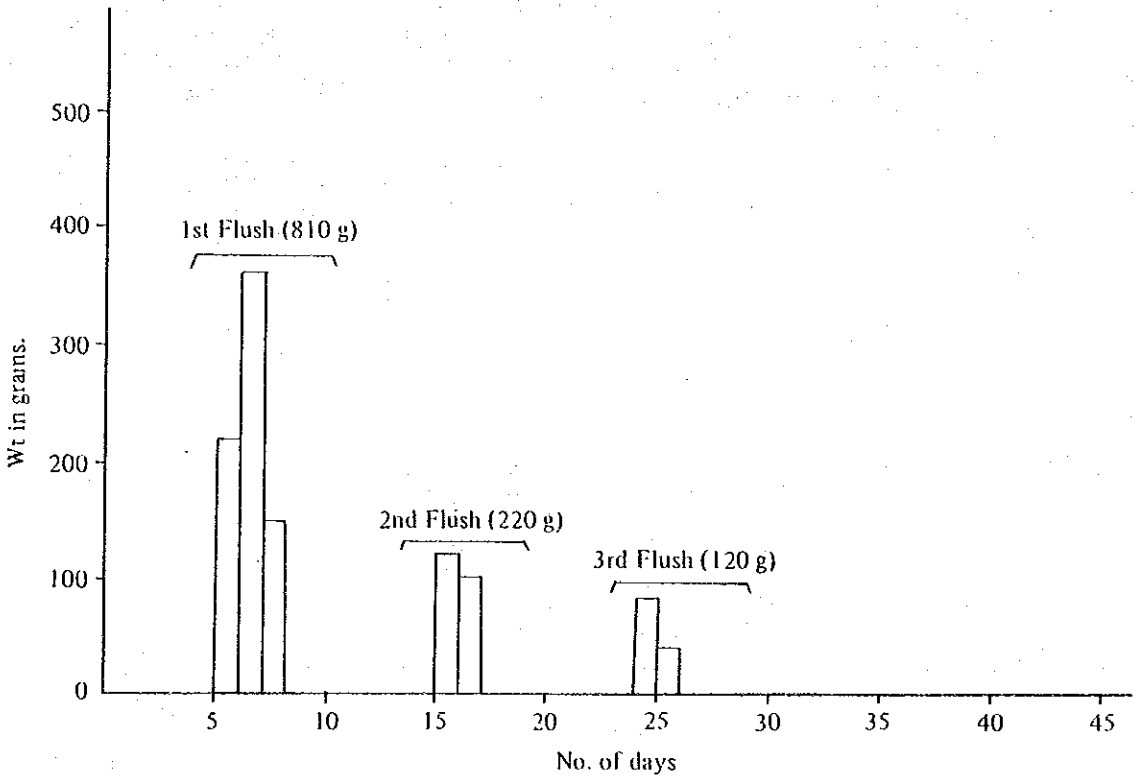


Fig. 21 A simple set up for Abalone mushroom/Black Jelly Fungi Growing at home

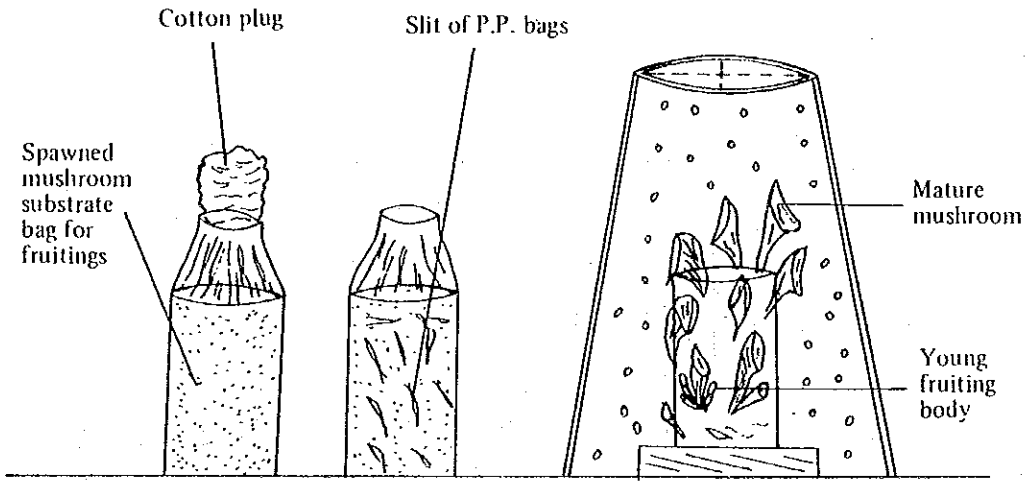


Fig. 22 Yield Pattern of 5 numbers (5kg wet wt) of Abalone Mushroom Spawned Bags

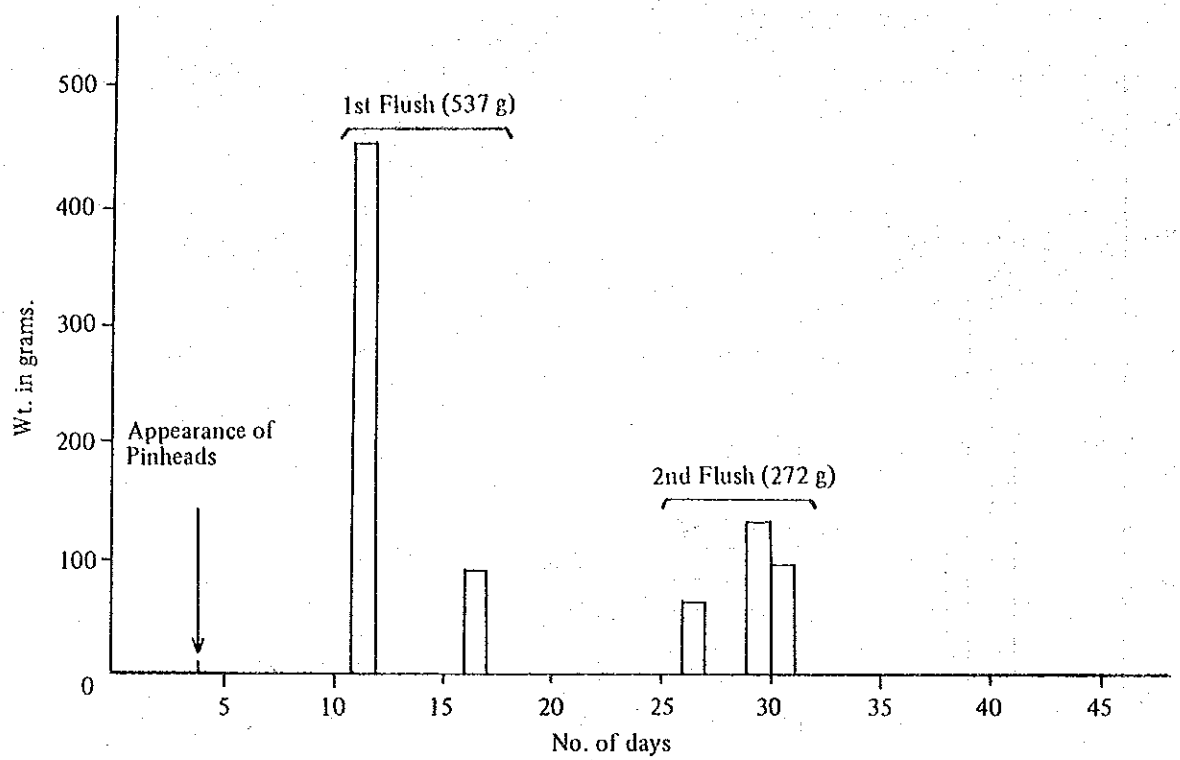
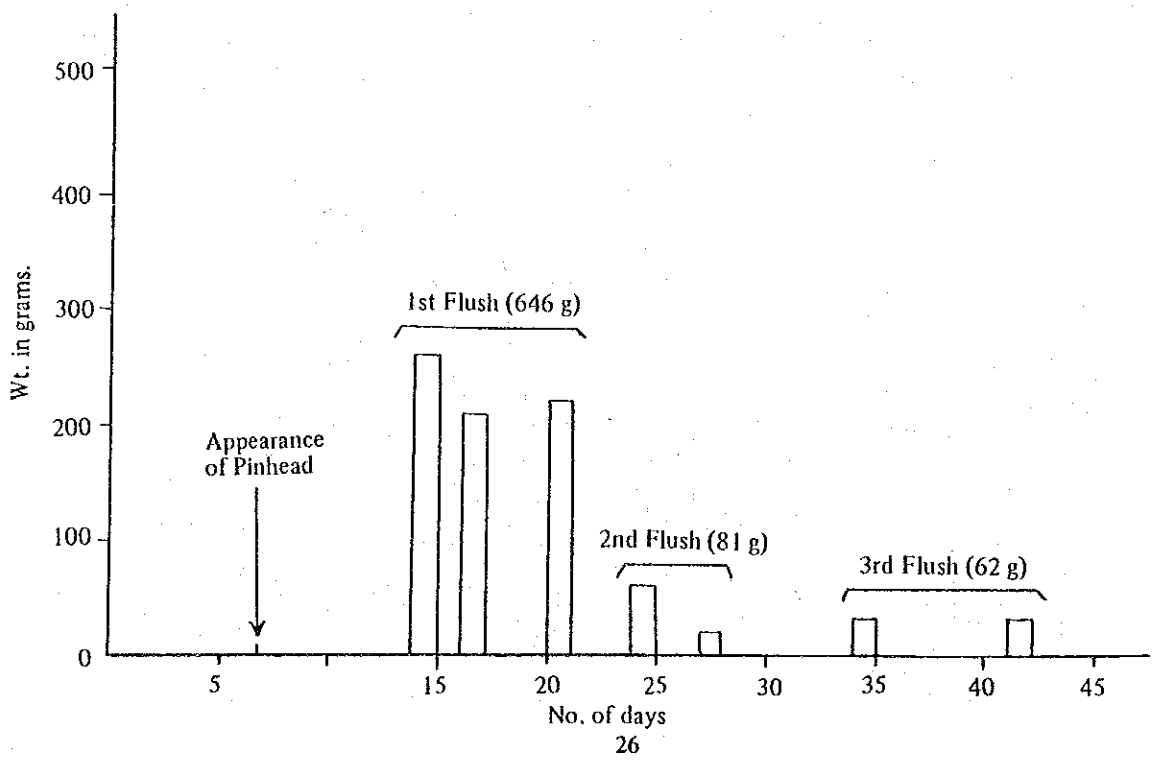


Fig. 23 Yield Pattern of 5 numbers (5kg wet wt) of Black Jelly Fungi Spawned Bags



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5. Cultivation of Other Edible Mushrooms

A summary of the cultivation techniques and choice of substrates and supplements used for growing some tropical types of edible mushrooms is given in Table 5.1. Cultivation techniques of other species of edible mushrooms have also been studied (Fig. 25 – 32). The basic steps are similar to those described above. Some species have shown potential for future development. A summary of the growing method of other edible mushrooms is presented in Table 5.2 for easy reference.

TABLE 5.1 A summary of the cultivation techniques and choice of substrates and supplements used for growing some tropical types of edible mushrooms

Common Name	Scientific Name	Main Substrate Used	Supplement Required	Temperature Requirement		*Growing Cycle	Yield (%)	Growing Method Used
				Incubation Period/ Spawn running	Cropping Period/ Fruiting			
1. Padi Straw Mushroom	*Volvariella volvaceae*	a) Raw cotton waste (100%) b) Rice strawrope (100%)	5% rice bran + 5% $CaCO_3$ –	Bed Temp. 28°-36°C 10-12 days	Bed temp. 28°-33°C 18-21 days	28-33 days	a) 25-30%* b) 18.1%*	Ridge beds on shelves
2. Abalone Mushroom	*Pleurotus cystidiosus*	Sawdust (80%) Cotton waste (20%)	Rice bran 15% Calcium carbonate 5%	20°-25°C 4-5 weeks	28°-30°C 6-8 weeks	9-12 weeks	20-25%**	Polypropylene bags on racks
3. White Oyster Mushroom	*Pleurotus florida*	Undercasing grade of cotton waste (100%)	Rice bran 5% Calcium carbonate 5%	20°-25°C 3-4 weeks	28°-30°C 3-4 weeks	6-8 weeks	73-84%*	PVC blocks on shelves
4. Grey Oyster Mushroom	*Pleurotus sajor-caju*	----------same as	above (3) ----------	----------	same as above	(3)----------	44-57%*	as above (3)
5. Pink Oyster Mushroom	*Pleurotus flabellatus*	----------same as	above (3) ----------	----------	same as above	(3)----------	78-86%*	as above (3)
6. Black Jelly Fungi	*Auricularia sp. strain J5*	Sawdust (80%) Cotton waste (20%)	Rice bran 15% Calcium carbonate 5%	20°-25°C 3-4 weeks	28°-30°C 6-8 weeks	9-12 weeks	25-30%**	Polypropylene bags on vertical racks

* Fresh weight/weight of dry substrate

** Fresh weight/weight of wet substrate

* Growing cycle = from spawning to termination of mushroom crop

TABLE 5.2 A summary of the cultivation techniques and choice of substrates and supplements used for growing other edible mushrooms

Common Name	Scientific Name	Main Substrate Used	Supplement Required	Temperature Requirement		*Growing Cycle	Yield (%)	Growing Methods
				Incubation Period Spawn running	Cropping Period/ Fruiting			
1. White Jelly Fungi	*Tremella fusiformis*	Mango wood	NIL	28°-30°C 2-3 wks	28°-30°C 16-17 wks	18-20 weeks	7.5%***	Wood logs
2. Button Mushroom	*a) Agaricus bisporus* *b) A. bitorquis*	Cotton Cropping (100%) Composting period for 4 weeks	Urea 1% $CaCO_3$ 3% $CaSO_4$ 3% Rice bran 2%	13°-18°C 4-5 weeks 20°-25°C 5-6 weeks	13°-18°C 10-12 weeks 20°-25°C 9-10 weeks	14-17 weeks 14-16 weeks	18.4 kg/m² 7.4 kg/m²	Shelf-system compost thickness = 20 cm
3. Ling Zhi	*Ganoderma lucidum*	Cotton Waste (60%) Sawdust (40%)	Rice bran 20% Calcium carbonate 5%	20°-25°C 3-4 weeks	28°-30°C 4-5 weeks	7-9 weeks	6.0%**	Polypropylene bags on vertical racks
4. Shiitake Mushroom (Strain WS13)	*Lentinus edodes*	Sawdust (80%) Cotton waste (20%)	Rice bran 15% $CaCO_3$ 5%	20°-25°C 4-5 weeks	25°-30°C 19-20 weeks	23-25 weeks	14.0%**	Polypropylene bags on vertical racks
5. Oyster Mushroom	*Pleurotus ostreatus*	Undercasing grade of cotton waste (100%)	Rice bran 5% Calcium carbonate 5%	20°-25°C 4-5 weeks	20°-25°C 4 weeks	8-9 weeks	43.74%*	PVC Blocks on shelves
6. Golden Mushroom	*Flammulina velutipes*	Sawdust (50%) Cotton waste (50%)	Rice bran 15% $CaCO_3$ 5%	20°-25°C 3-4 weeks	8°-16°C 7 weeks	10-11 weeks	13.2%**	Polypropylene bags on vertical racks
7. Agrocybe Mushroom	*Agrocybe aegerita*	Sawdust (80%) Cotton waste (20%)	Rice bran 15% $CaCO_3$ 5%	20°-25°C 3-4 weeks	18°-25°C 12 weeks	15-16 weeks	6.6%**	as above (6)
8. Nameko Mushroom	*Pholiota nameko*	Sawdust (80%) Cotton waste (20%)	Rice bran 15% $CaCO_3$ 5%	20°-25°C 3-4 weeks	10°-15°C 12 weeks	15-16 weeks	16.3%**	as above (6)

* Growing cycle = from spawning to termination of mushroom crop
* Fresh weight/weight of dry substrate
** Fresh weight/weight of wet substrate
*** Fresh weight/weight of initial fresh log

LIST OF ILLUSTRATIONS

LIST OF APPENDICES

Appendix 1. Agar media for pure mycelial culture

A. Potato Dextrose Agar

Fresh Potato (or Tomato)	200 g
Dextrose	20 g
Agar	20 g
Distilled Water to	1 litre
Adjust pH to 7	

Procedure:

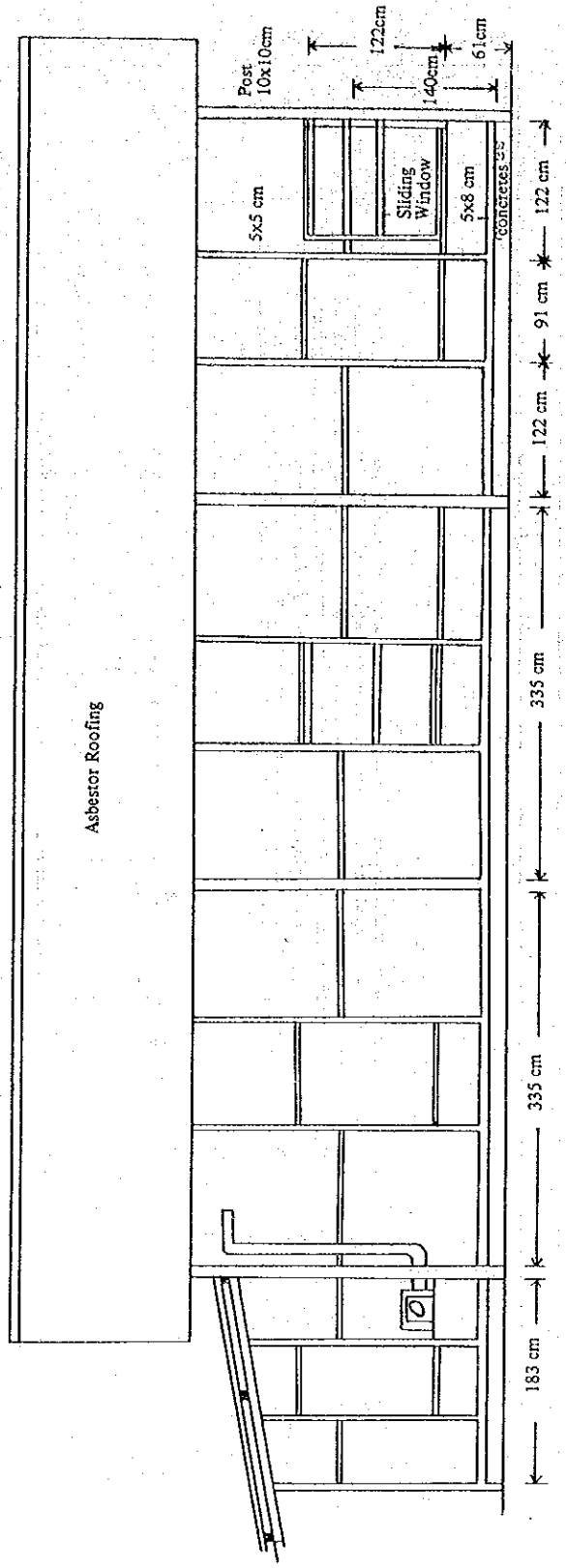
1. Wash potato clean and cut into small cubes.
2. Weigh out the 200 g required, place into a beaker and add in 1 litre of water.
3. Boil and simmer for about 30 minutes.
4. Filter through muslin cloth and squeeze the cloth to obtain as much pulp as possible.
5. Add 20 g Dextrose and 20 g Agar to the semi-liquid potato.
6. Boil and stir till dissolved.
7. Finally make up to 1 litre.
8. Autoclave to sterilize the media at 1.1 kg/cm ^{2} for 20 minutes.

B.

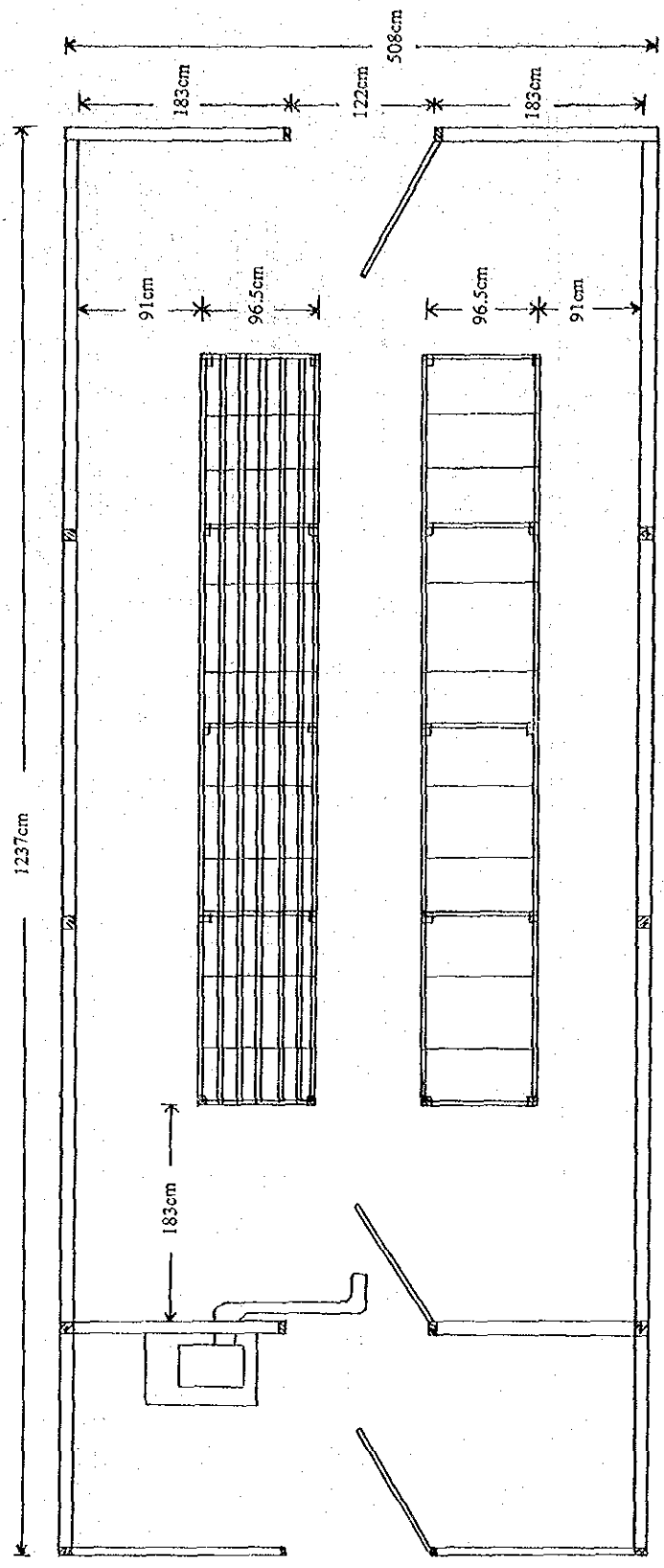
Apple	100 g
Peptone	2 g
Sucrose	20 g
Agar	20 g
Distilled water to	1 litre
Adjust pH to 7	

Procedure: Same as above

Appendix 2 Polyethylene Mushroom House (Front View)

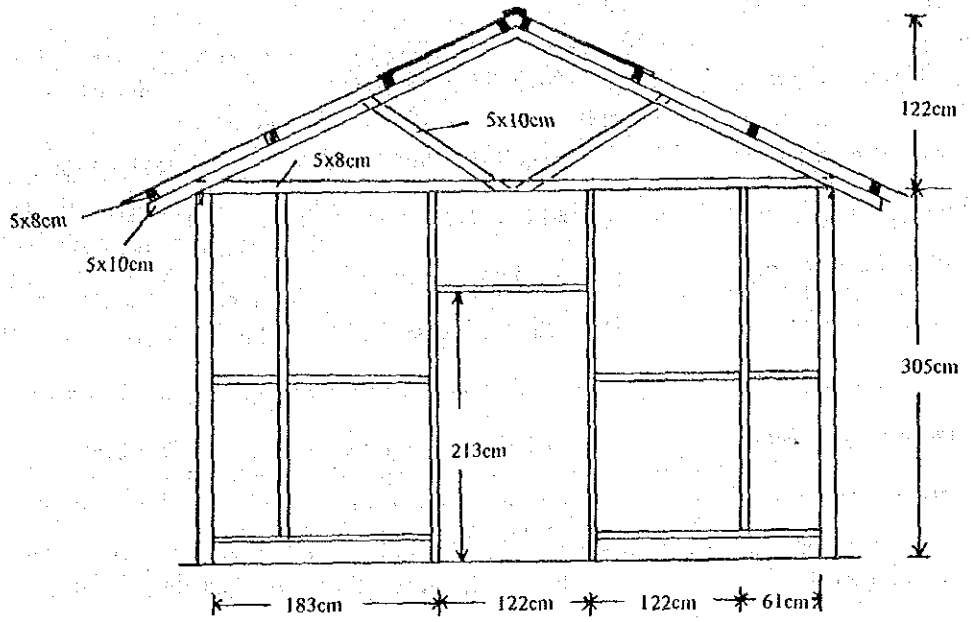


Appendix 3 Polyethylene Mushroom House (Plan View)

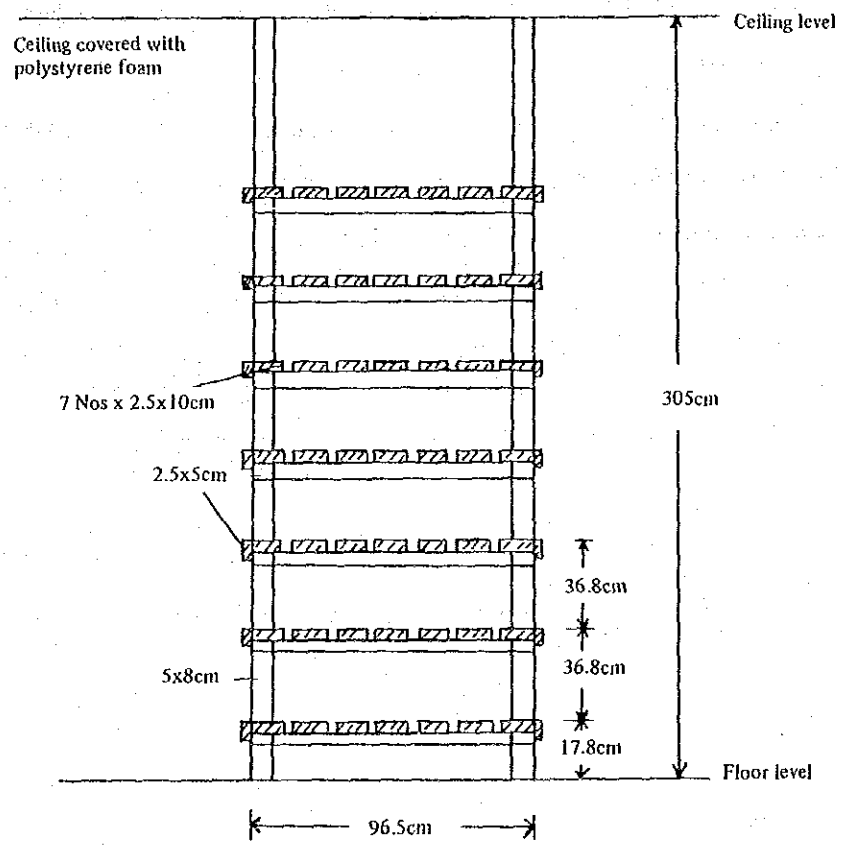


All walls lining with chicken wire mesh 5cm
gate and covered with P.E. sheets

Appendix 4 Polyethylene Mushroom House (End View)



Appendix 5 Details of Mushroom Shelf Made of Hardwood Timber, (Chengal)



Appendix 6

LIST OF EDIBLE MUSHROOMS

Scientific Name	Common Name	Chinese Name
1. *Volvariella volvaceae*	Padi Straw Mushroom or Chinese Mushroom	草菇，包脚菇，廣東菇，中國菇
2. *Pleurotus cystidiosus*	Abalone Mushroom	鮑魚菇，黑美人菇
3. *Pleurotus florida*	White Oyster Mushroom	蠔菇，平菇，白菇
4. *Pleurotus sajor-caju*	Grey Oyster Mushroom	灰蠔菇，鳳尾菇
5. *Pleurotus flabellatus*	Pink Oyster Mushroom	珊瑚蠔菇
6. *Agaricus bisporus*	Button Mushroom or Champignon	洋菇，磨菇
7. *A. bitorquis*	Button Mushroom (Warm Strain)	高溫磨菇
8. *Lentinus edodes*	Shiitake Mushroom or Black Chinese Mushroom	香菇，冬菇，香信
9. *Flammulina velutipes*	Golden Mushroom	金針菇，金菇
10. *Pholiota nameko*	*Nameko* Mushroom	眞珠菇，鱗菇
11. *Agrocybe aegerita*	*Agrocybe* Mushroom	田頭菇
12. *Auricularia polytrichia*	Black Jelly Fungi	黑木耳，木耳
13. *Tremella fusiformis*	White Jelly Fungi	白木耳，銀耳，雪耳
14. *Ganoderma lucidum*	Ling Zhi	靈芝，靈芝草，靈芝菌

REFERENCES

Balazs, S. & Szabo I (1979) . Temperature requirement. Studies of some new mushroom species in culture. Mush. Sci. X Part 2 pp 421-427

Borromeo, J. D. (1967) : Some physiological responses of *Auricularia polytrichia* (Mont.) Sacc. in laboratory culture. Phillippine Agriculturists 51(6) : 486-550

Chang S. T. (1972) : The Chinese Mushrooms *(Volvariella volvaceae).* The Chinese University of Hong Kong

Chang S. T. (1974) : Production of Straw Mushroom *(Volvariella volvaceae)* from cotton waste. The Mushroom Jornal 21 : 348-352

Chang S. T. (1977) : Biological and commercial aspects of Straw Mushroom *(Volvariella volvaceae)* cultivation. Mushroom Sci. 9(2) : 157-165

Chang S. T. & W. A. Hayes (1978) : The biology and cultivation of edible mushrooms. Academic Press. New York & London.

Chang S. T. (1979) : Cultivation of *Volvariella volvaceae* from cotton composts. Mushroom Sci. 10(2) : 609-18.

Chang S. T. & T. H. Quimio (1982) : Tropical mushrooms. Biological Nature and Cultication Methods. The Chinese University Press. Hong Kong.

Cheng S. & C. C. Tu (1976) : A study on the effects of different temperature on the mycelial vigor of *Auricularia polytricha* (Mont.) Sacc. J. Chin. Soc. Hortic. Sci. 22(4) : 152-160

Cheng S. & Han Y. S. (1977) : Study of the effects of environmental factors on development of Abalone Mushroom *(Pleurotus abalonus).* Taiwan Mushroom 1(1) : 2-10

Cheng S. & C. C. Tu (1978) : *Auricularia spp.* In The biology and cultivation of edible mushrooms; edited by S. T. Chang and W. A. Hayes. New York : Academic Press.

Chua S. E. & S. Y. Ho (1973) : Fruiting on sterile agar and cultivation of straw mushroom on paid straw, banana leaves and sawdust. World Crop 25 : 90-91

Chua S. E. (1974) : Cultivation of Straw Mushroom *(Volvariella volvaceae)* Using different substrates in multi-tiered racks. Mushroom Sci. 9 (Part I 1976)

Chua S. E., P. C. Leong & S. Y. Yong (1975) : Preliminary investigations into the feasibilities of growing Button Mushroom *(Agaricus species)* in insulated air-conditioned rooms in Singapore. Singapore J. Pri. Ind. 3(2) 128-135

Chung K. Y. & S. T. Chang (1972) : Cotton waste for indoor cultivation of straw mushroom. World Crop 24 : 302-303

Decaire J. R. (1978) : Economics of cultivated mushrooms. In 'The biology and cultivation of edible mushrooms' edited by S. T. Chang and W. A. Hayes. Academic Press. New York 1978.

Hu K. J. et al (1974) : The comparison of composts made of different raw materials for *Volvariella volvaceae*. Mushroom Sci. IX pp 687-690

Hu K. J. et al (1974) : Studies on sugarcane rubbish for Chinese Mushroom culture and growth factor. Mush Sci. IX pp 691-700

Jandack C. L. & Kapoor J. N. (1974) : Studies on the cultivation of *Pleurotus sajor-caju* (Fr.). Mush. Sci. 9 1:667

Kalberber P. P. (1976) : The cultivation of *Pleurotus ostreatus:* Experiments to elucidate the influence of different culture conditions on the crop yield. Mush. Sci. IX pp 653-662

Leong P. C., T. A. Yong & S. E. Chua (1978) : The use of cotton waste for the production of Straw Mushroom in Singapore. Singapore J. Pri. Ind. 6(2) : 63-68.

Leong P. C. (1980) : Utilization of cotton waste substrate with temperature treatment for the cultivation of Oyster Mushroom *(Pleurotus)* in Singapore. Singapore J. Pri. Ind. 8(1) : 21-27.

Leong P. C. (1982) : Cultivation of *Pleurotus* mushrooms on cotton waste substrate in Singapore. In Tropical Mushrooms (Chang & Quimio 1982) pp. 349-361. The Chinese University Press. Hong Kong

Lim W.C. (1981) : The Microbiology of Paddy Straw compost for the cultivation of *Volvariella volvaceae*. Mushroom Science, Part II pp 595-602

Quimio T. H. (1978) : Indoor, cultivation of *Pleurotus* Mushrooms. UPLB Bulletin.

San Antonio J. P. & C. Fordyce Jr. (1972) : Cultivation of the paddy straw mushroom, *Volvariella* (Bull, ex. Fr.) Sing. Hortiscience 7: 461-464.

Singer, R. (1961) : Mushroom and its Truffles Interscience Publishers.

Tan K. K. (1981) : Cultivation of the Oyster Mushroom, *Pleurotus ostreatus* on cotton waste. Mushroom Science XI Part I pp 697-703

Tolentino P. R. (1981) : Mushroom culture utilising Tobacco Waste. Mushroom Science 11 (Part 2) : 577-584.

Tu, C. C. & S. Cheng (1975) : The Genus *Auricularia* in Taiwan. J. Chin. Soc. Hortic. Sci. 21(5) : 227-33.

Yong T A & S E Chua (1975) : Cultivation of padi straw mushroom *(Volvariella species)*. Agri. Handbook No. 2, Primary Production Department, Singapore.

Zadrazil F. (1974) : The ecology and industrial production of *Pleurotus ostreatus, P. florida, P. cornucopiae* and *P. eryngii*. Mush. Sci. IX: 621-652.

Zadrazil F. (1978). Cultivation of *Pleurotus*. In the biology and cultivation of edible mushrooms edited by S. T. Chang and W A Hayes. New York: Academic Press.

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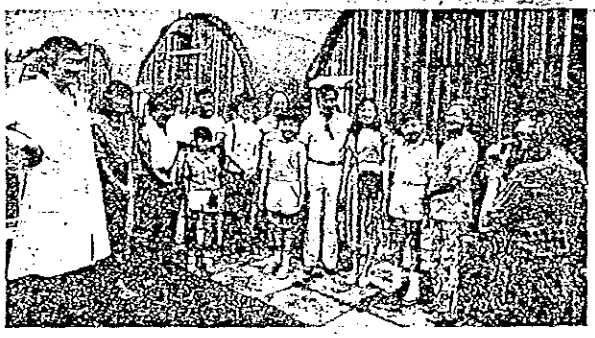
別添資料 2

Mushrooms: Eat them fresh

PICTURES: SHAFIE GOH

ABOVE: *Miss Wei showing off the farm produce; BELOW: Miss Wei shows the visitors the dried and fresh mushrooms.*



EAT MUSHROOMS and eat them fresh. If you don't know how, we'll show you, says Everbloom Mushroom (Pte) Ltd in its latest promotion effort to let people know that fresh mushrooms are available in Singapore.

People are so used to buying dried mushrooms imported from Japan or Taiwan that they are probably not aware of the health benefits of the fresh product; so the company now holds an open house every Sunday.

Singapore's mushroom business was set up by Dr K K Tan, a National University of Singapore bio-chemistry lecturer turned entrepreneur.

"The idea is to get Singaporeans to eat fresh mushrooms because right now they are eating them in the dried form," said Dr Tan.

Shiitake mushrooms are supposed to contain lentinan, an anti-cancer substance and on top of that a fresh fruit or vegetable is always better than the dried version.

The response to the open-house sessions at its farm in Seletar West Farmway 5 has been very good, said Dr Tan.

"We've had over 300 visitors since June 16," Dr Tan said.

Visitors are taken on a tour of the farm and are given cooking demonstrations of a couple of recipes on different ways of cooking Shiitake mushrooms (the succulent black Chinese mushrooms).

The farm produces about 300 kilogrammes of shiitake mushrooms per day from its 29 greenhouses.

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BANGKOK.

MUSHROOM SHITAKE

In Thailand, it was thought that mushroom shitake could be cultivated just in cool countries because in the past time, mushroom shitake cultivation was merely done in China, Japan, Korea and Taiwan. And those countries are in Temperate zone or between 30° and 50° longitude but Thailand is situated at 20° to 30° longitude.

Climate of Thailand

1. Temperature is approximately between 10° and 40°C.
2. Humidity is ranging 20 to 80 %
3. Whereas Thailand is in Tropical zone, there is no Autumn and consequently all of the trees are sap woods.
4. There are some kinds of hard wood in Thailand but it is too hard to use for cultivating mushroom.
5. The quantity of rain is insufficient.
6. It is too dry in dry season and too much rain in rainy season.

Mushroom Cultivation

We must exactly consider all of the statements mentioned above before we cultivate mushroom.

Ten thousand years age, Borneo was the original country where mushroom shitake was found. The wind and typhoon then blew the spore of mushroom to Japan, Korea and Taiwan. Such spore fell down on Oak Trees in Japan. Eight years after that, mushroom shitake grew in Maehongsorn the top most part of Thailand, Which was heard to have grown there naturally. Unfortunately there was no serious study about mushroom shitake in Thailand, so, we could not explain the origin of it.

(/)

The fact that Thailand is situated between 20° and 30° longitude , the same zone as Borneo , made us guess that mushroom shitake could be cultivated in Thailand. According to the survey, the provinces suitable for mushroom cultivation are Fang, Tak, Maehongsorn, Cheingrai. These provinces are about 1,000 metres over the sea level. Unfortunately we cannot utilize those areas, but we have found Cheingmai can serve in place of all.

We have tried cultivating mushroom shitake in different kinds of wood such as Mango, Mangosteen, Lynchee, and many others. The result has shown that the most suitable wood supplied to cultivate mushroom shitake is Oaks wood. Regretfully, this kind of wood was preserved by the Thai Government and therefore cutting of such wood was prohibited. In Japan, they used Shinoki and Kunoki woods which had the same characteristics as Sanunt Nuam wood. Mizunara, Kumara and Abemaki woods can be used for mushroom cultivations. The experiment of mushroom cultivation in Thailand for the first two years failed because we lacked feasibility study of the climate in Thailand. This failure was due to the imitation of the Japanese process to cultivate. But in the third year,mushroom, whose spore we had already cultivated, was found on Sanunt Nuam, Haeng woods. Especially on Sanunt Nuam woods, we got much more favorable result, This was the first step leading us to another great one. We can now bravely announce that such woods are extremely suitable to cultivate mushroom shitake.

The Principles of Cultivating Process

1. We must be thinking of the difference between dry season and rainy season. Spore of mushroom will die in the following reasons:-

(2)

a. The weather is too dry.

b. The temperature is higher than 40°C.

c. The humidity is up to 100 %

d. The cultivating area is dirty or mold and other germs are found therein.

There are some others points we must be thinking of before cultivating mushroom.

e. Spore of mushroom looks like Bacteria.

f. The area used for cultivating mushroom must be all the time clean.

g. The suitable humidity is between 60 % and 90 %

h. Oxygen is much essential.

2. The process for Mushroom cultivation is different from that for other plants. The latter we need seeds to cultivate. Unless it is grows, we can see its embryo, from which we can study the way it grows. If it is infected by any germs, we will suddenly find it. But the infection for mushroom cultivation, different from other plants, we must insert the spore into the cultivating wood and that is why we cannot see its growth. Therefore we must pay much attention to the cultivation.

3. Methods in choosing the cultivating area.

3.1 Spore of mushroom is one kind of fungi.

3.2 There are some points of view in cultivation, namely:

a. Evaporation.

b. Oxygen.

c. Charactor of wood.

3.3 Using water mixed with less iron ore.

(9)

3.4 Using humid soil; the soil must be humid and well assimilate and should have the following characteristic;

a. Well assimilate.

b. Having less iron ore in its composition.

c. Being sand soil.

3.5 The cultivating area should not get much sunlight like the following places;

a. With big trees nearby.

b. A little bit sunlight.

c. The wind easily passing though.

d. Valley and hill will be better than plain.

3.6 Soil in that area should well absorb water such as there should be water way in the valley.

3.7 Morning and evening are the best time to cultivate.

3.8 The temperature should range from 5-6°C to 30-32°C.

3.9 Humidity should be from 60 % to 95 %.

3.10 The area should be clean, with no fungi therein.

Precaution

The clauses above are very important because there will be no corps if we choose the wrong area.

4. The way of choosing the cultivating wood;

Sanunt Nuam wood is softer than Oak wood and Sanunt Nuam grain is rougher than wild Chestnuts (Oak). We cannot calculate Sanunt Nuam's age because it has no annual ring. Sanunt Nuam woods, suitable for cultivating, should be about 5 to 15 years known by measuring its surface. Its diameter should be from 3 to 8 Inches and should have the following characters:

(4)

4.1 Thick bark.

4.2 Rougher bark is better.

4.3 Choose the heavy wood.

4.4 Wood that is dirty or drilled by insects is forbidden .

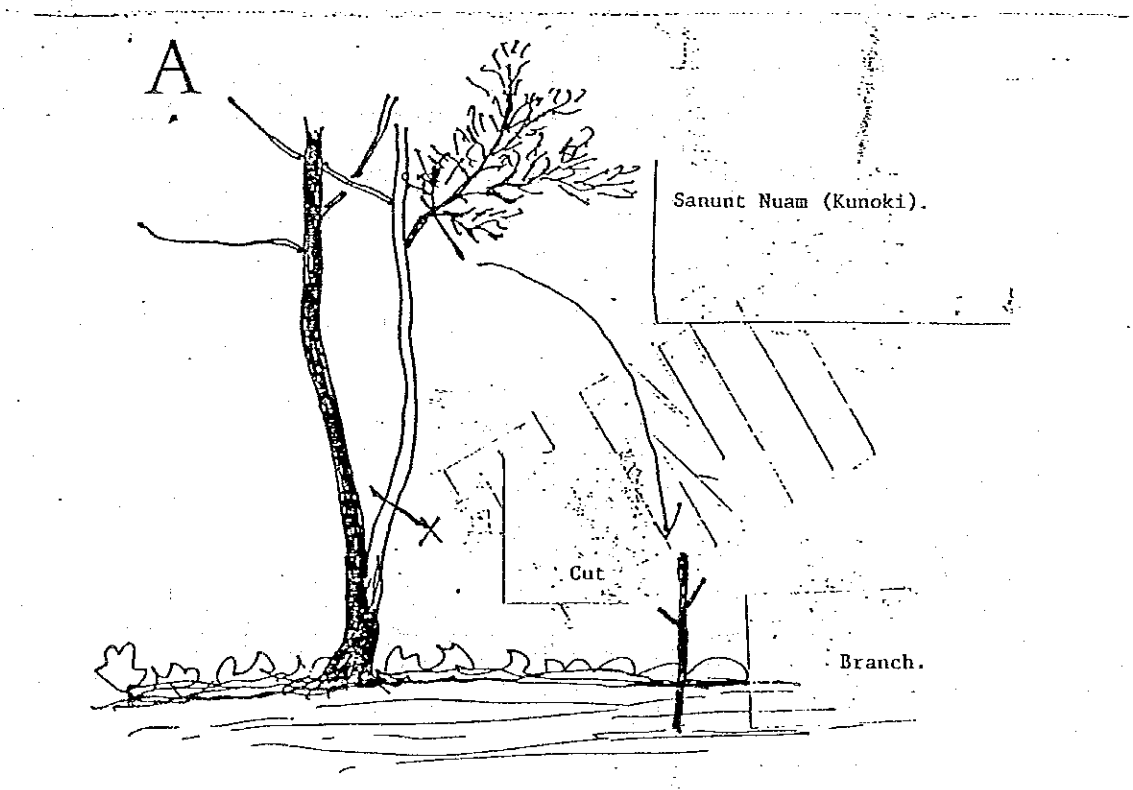
4.5 Wood that nearly become fungi such as red, white, blue or black fungi, is forbidden too.

4.6 Wood should be about 90 cm. long because in the process of cultivating, we should supply enough quantity of water and let the wind passing through.

Precaution

(1) Mushroom cultivation can do in every season, the important thing of this process is spore of mushroom and cultivating woods. So we should spread out this species, afterward, we had cut its branches, prunning it.

(2) The way to cut a branch for prunning.(see Picture A)



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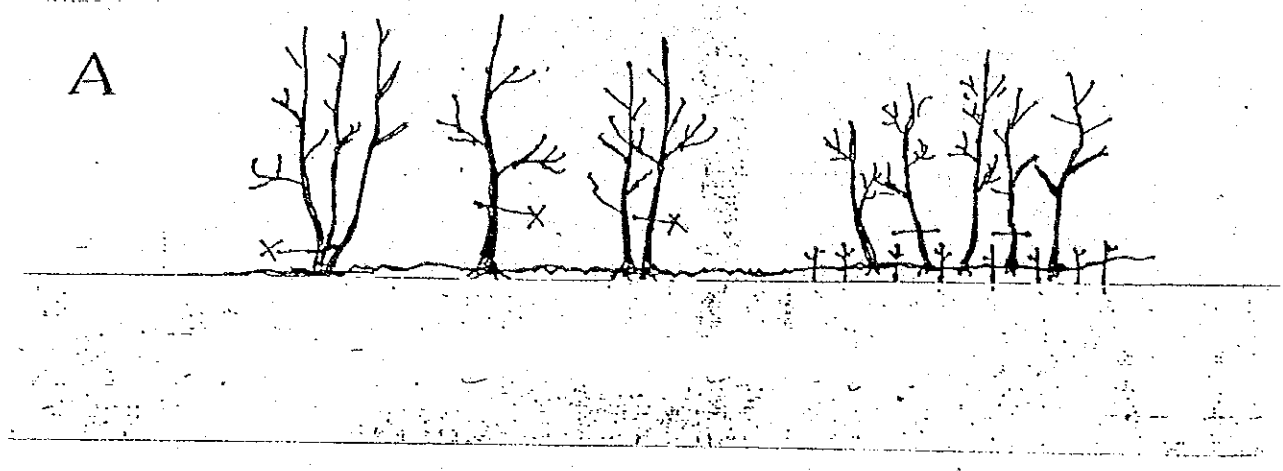


If the trees have three branches, we should cut just two of them and leave the other to grow up.

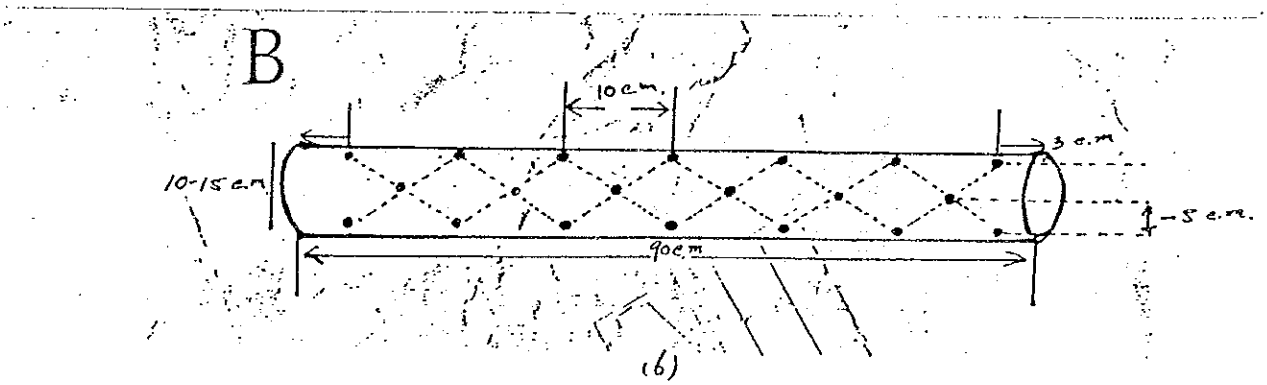
5. How to insert the spore into the wood.

Spore of mushroom can be divided into two kind, namely: saw-dust and cock.

Cock spore can be preserved longer than Saw-dust but the latter can be more quickly spreaded out into the wood than the first.

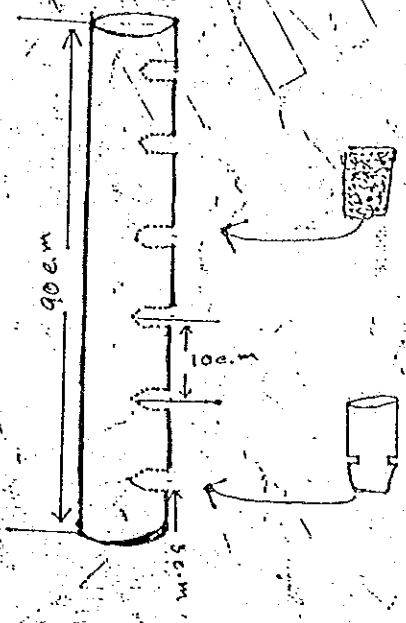
5.1 Character of wood; we must check the humidity of that wood before we will use it. If it is too dry, we should put it into the water for about 10 hours. Unless it is dry, we will do nothing.

5.2 Process of insertion: drill the wood.(see Picture B)



(6)

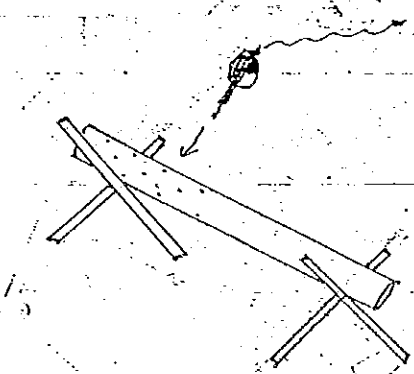
B



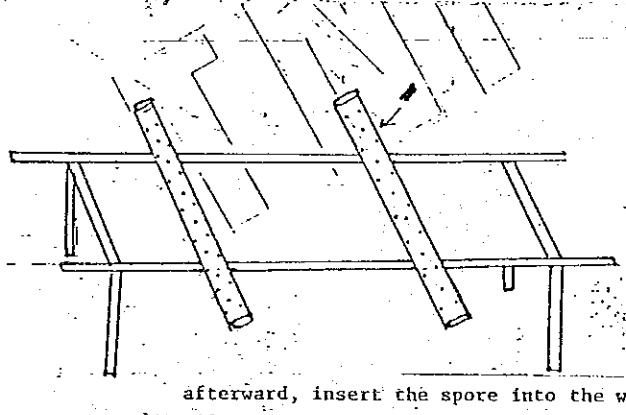
Saw-Dust Spore.

Cock Spore.

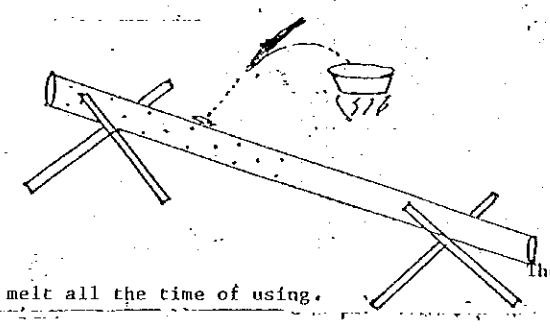
B



The way to drill the wood.



afterward, insert the spore into the wood.

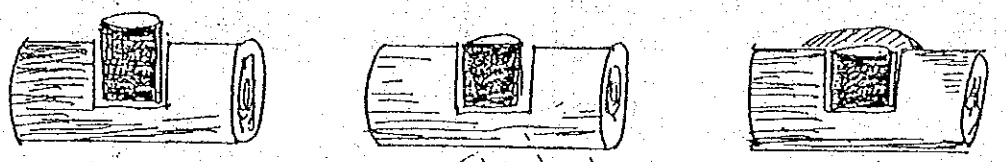


then cover the hole by wax

P.S. wax must be melt all the time of using.

After drilled and put the spore into such holes, we should cover them by melting wax. Use tiny brush put on the melting wax to cover the holes in order to prevent from any germs killing the spore. (see Picture C).

C



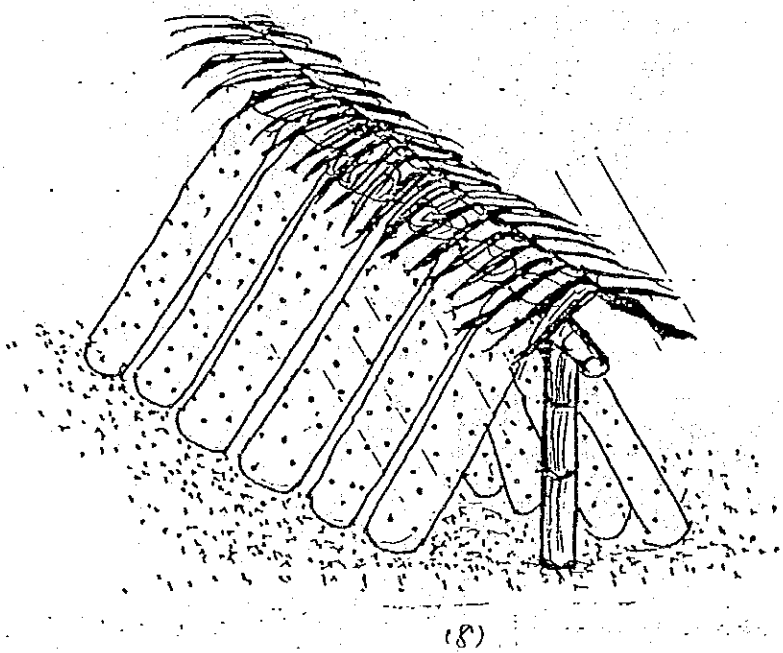
(1) Unless we tighten the spore, it will die.

(2) We must put the spore into the wood.

(3) Cover such hole by wax.

6. How to put the position of woods, we insert the spore (see Picture D.) below.

D



(8)

After we inserted the spore into the woods and covered such holes by wax, we should put them stand (see Picture D.) and put the coconut leave etc., on them.

Precaution

(1) Let's the wind easily pass through.

(2) Keep the humity up to 60 %.

(3) Keep the temperature lower than 30° C.

(4) The way to keep the correct temperature and humidity: If the temperature is higher than the said limitation, we should put the coconut leave over the cultivating area and water on that leave to reduce the temperature and to keep the humidity.

(5) If the humidity is lower than 60 %, we should water on the ground to increase the humidity.

(6) Quantity of water to supply: It is depended on whether it is dry season or rainy season. In dry season, keep watering three times a day. In rainy season, just keep watering once a day on which it is not raining. And if the humidity is higher than 60 %, water is not necessary.

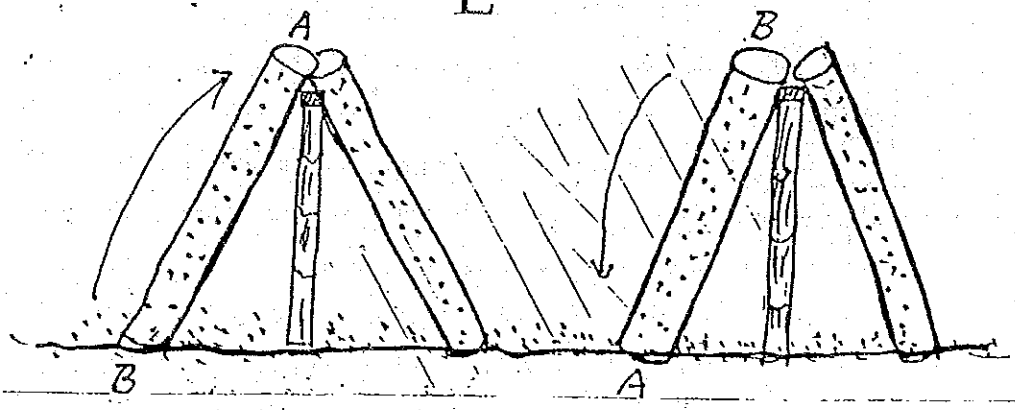
(7) In rainy season, we must cover the cultivating area with plastic sheet in case of two days raining. Because much humidity will easily make the wood being fungi.

(8) Keep such area out of direct sunlight, unless the spore which is the same charactee of bacteria will be kill. On the other hand the growth of the spore must depend on sunlight too. So we must let sunlight passing through the curtain on such wood.

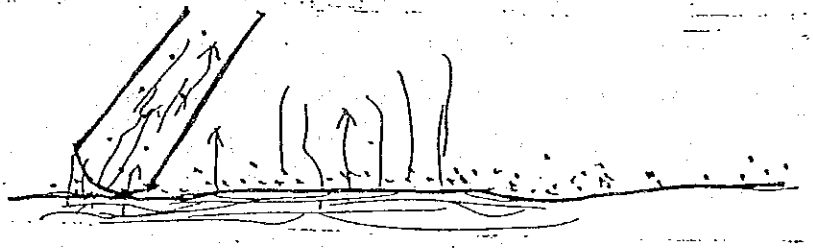
(9) Every ten days, we must turn such wood up side down. (see Picture E.)

(9)

E



Every ten days, turn the wood up side down as the picture above.



Let's the humidity assimilating in the wood.

(10)

7. The conclusion

From the starting date of inserting the spore to 6 months afterward, this is the most important period because the spore will die unless the insertion or the maintenance is correct.

If any fungus, such as red, black, white and blue fungi, are found on that wood, use a brush and cloth to wipe them out and we will do the following process:

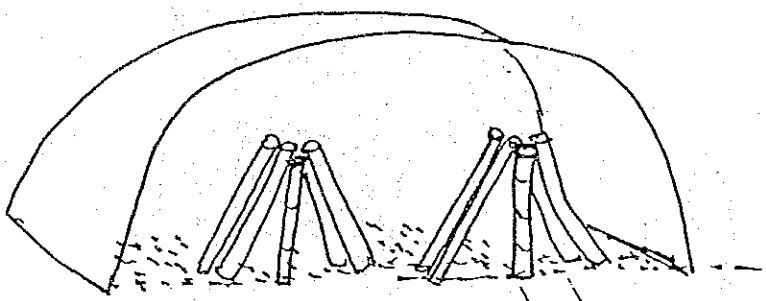
a. If the weeds grow in the cultivating area, root out of them.

b. On the cultivating area, topped it by sand or better by pebbles.

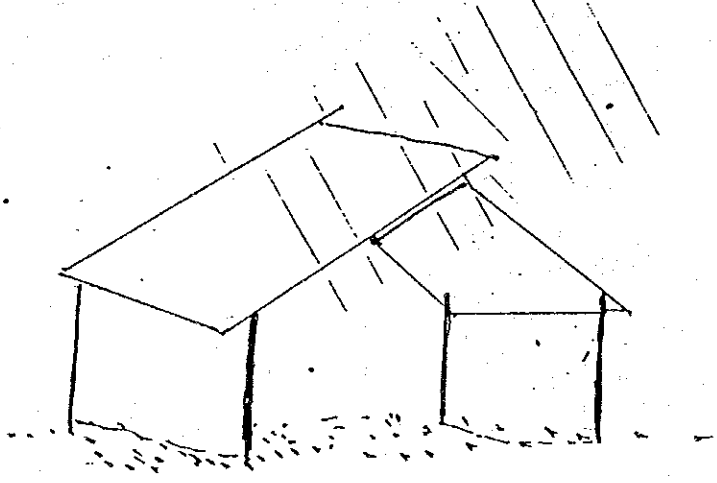
c. If its is heavy raining, use plastic sheets or coconut leaves as a roof to cover such area.(see Picture F.)

F

1.



2.

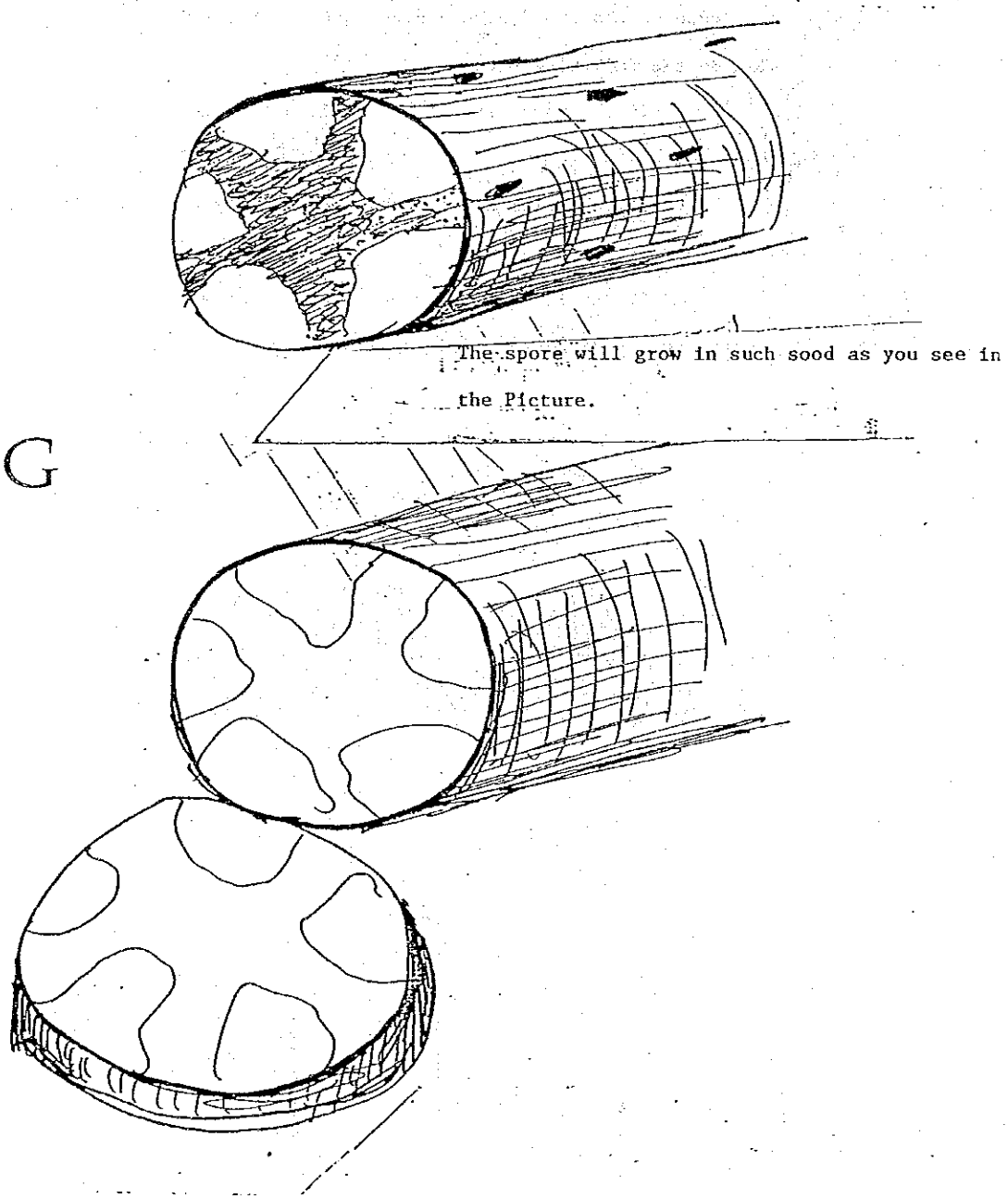


Thatched house can be built into two types, see the pictures above.

(ก)

8. Between 5 and 7 months, if every process is correct, on the surface of such wood, white ring like flower will appear, this means the spore of mushroom grow up. Cut that wood into 2 or 3 pieces, about 5 cm. long per piece. (see Picture G.).

G

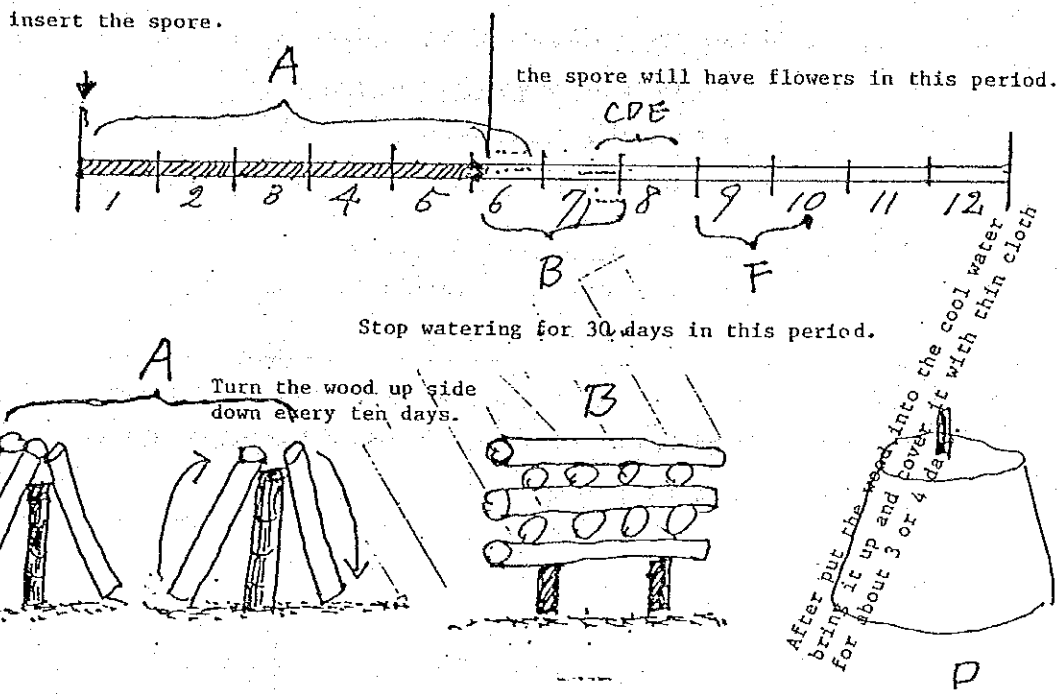


The spore will grow in such sood as you see in the Picture.

If you are unsure, cut the wood to see the surface inside.

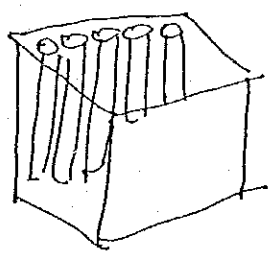
(12)

The picture below show that full growth of spore will naturally become mushroom flower.

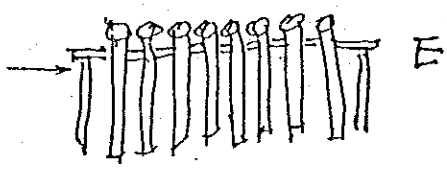


Put the wood stand as the picture above.

C



After stop watering for 30 days, freeze such wood at 10°C or 15°C for about 15 or 20 hours.

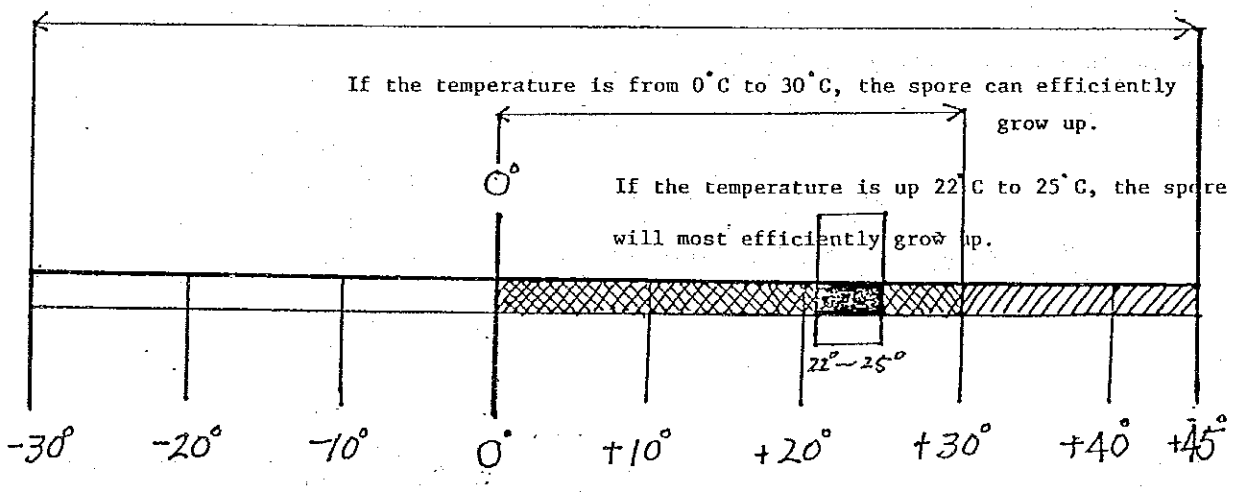


After cover such woods with cloth for 3 or 4 days, arrange them in order as seeing in the picture and do not water them from which mushroom flowers grow.

Suitable temperature to cultivate mushroom must be as diagram below.

1. Spore will be strong in the correct temperature.
2. The spore will die in the following reasons:
   2.1 Cultivating wood is too dry.
   2.2 Supply a lot of water.
3. The spore will not die although the temperature is up to 30°C.
4. The best humidity is between 60 % and 80 %.

If the temperature is below from -30°C to -45°C, the spore will be still alive but cannot grow up.



(14)

The way of choosing the wood.

1. Know the names of each species of woods.
2. Bark of wood should not be drilled.
3. Age of wood should be approximately up to 5 years.
4. Know whether such wood was drilled by any insects or not.
5. Have any fungus thereon ?

How many drills according to the size of wood.

SIZE OF WOOD.	NUMBER OF ROW.	NUMBER OF DRILLS.	TOTAL OF DRILLS.
Not over 6 cm.	4	4 multiply 8	32
" 9	5	5 " 8	40
" 10	5	5 " 8	40
" 11	6	6 " 8	48
" 12	6	6 " 8	48
" 15	7	7 " 8	56

(15)