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Chili (*Capsicum* spp.) Food Chain Analysis: Setting Research Priorities in Asia

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EDITOR

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Introduction

Chili is an important and essential component of the daily Indonesian diet. It is mainly consumed in fresh semi crushed form, locally known as "Sambals" (RIV 1996). It is also an important commercial crop grown year-round mainly by small farmers both in high and lowlands under rainfed as well as irrigated conditions. In 2003, it was cultivated on a total area of 176 thousand ha producing about 1.1 million t of fresh weight with an average yield of 6.1 t/ha. The importance of chili in the Indonesian diet and cropping systems in certain areas demands systematic efforts in understanding the production, consumption, and marketing aspects of the whole sector. Lack of information at the national level will hamper appropriate planning of the sector, and keep it far below its potential. This study was designed to fill the information gaps, and to provide an analytical look of various issues at different food chain levels in Indonesia. The data used in this analysis were collected from secondary sources as well as through surveys from various stakeholders along the chili food chain.

Indonesia is located at the crossroads of the ancient world, spanning the trade routes between the Middle East and Asia. The country is the largest archipelago in the world with 33 provinces and approximately 13,000 islands. It is not surprising that traders, immigrants, and even pirates were enticed by the riches of these "Spice Islands". During the 1st to 7th centuries AD, Indian traders not only introduced the Sankrit, Buddhism and Hinduism, they also brought with them cucumber, eggplant, and cowpeas and assimilated curries into the native cuisine. Europeans, including the Dutch, Portuguese, Spanish, and British, in their search for spices, began arriving in the early 16th century and introduced temperate vegetables like tomato, chili, pepper, squash and pumpkin. (Recipes4us 2003; Freeman 2005).

The territory of the Republic of Indonesia stretches from latitudes 6°N to 11°S and from longitudes 95°W to 141°E. Indonesia consists of five big islands: Java, Sumatra, Sulawesi, Kalimantan, and Irian Jaya. Chili is grown mainly in East Java, Central Java, West Java and North Sumatra. More than 23% of chili production was harvested from West Java followed by 19% and 12% from East and Central Java, respectively (Table 1).

Table 1. Chili area and production by province, Indonesia, 2003

Province	Harvested area		Production in fresh weight		Yield in fresh weight
	(ha)	(%)	(t)	(%)	(t/ha)
East Java	40,553	23.0	197,989	18.6	4.9
Central Java	26,900	15.3	127,149	11.9	4.7
West Java	20,304	11.5	247,300	23.2	12.2
North Sumarta	17,345	9.8	132,943	12.5	7.7
West Sumarta	8,260	4.7	49,073	4.6	5.9
Aceh	10,304	5.8	42,836	4.0	4.2
Bengkulu	8,782	5.0	32,639	3.1	3.7
South sulawesi	7,031	4.0	31,929	3.0	4.5
Other	36,785	20.9	204,864	19.2	5.6
Total	176,264	100.0	1,066,722	100.0	6.1

Source: Directorate General of Food Crops and Horticulture (2004).

Primary Data Collection

Primary data on various aspects related to production, consumption, marketing, and processing of chili and production aspects of competing crop were collected from three major chili-producing provinces of the country, namely West Java, Central Java and East Java (Table 2). In each province, three to four districts or sub-districts were chosen in consultation with the provincial Department of Agricultural Extension (DAE). These districts or sub-districts include Wanasari, Peservani, and Cikajaing from West Java; Brebes, Tanjung and Kersana from Central Java province; and Pelem, Singnalan, Kepuh, and Nagnanpal from East Java. One or two major chili-growing villages were selected from each district/sub-district, again in consultation with DAE. Depending upon the availability of farmers, 10 to 25 chili and two to five non-chili farmers and their wives were randomly selected from each village. The survey team visited 14 villages. The survey was conducted during the months of September and October 2002 and the production data covered the crop harvested in the same year.

Table 2. Frequency distribution of the sample respondents by region and province, Indonesia, 2002

Type of respondent	West Java	Central Java	East Java	Total
Chili farmers	86	84	86	256
Non-chili farmers	17	16	17	50
Chili farmer housewives (HW)	75	84	84	243
Non-chili farmer housewives	16	13	17	46
City housewives (Jakarta)				62
Market agents (Jakarta, Pedagang Pengumpul Desa, Karamat Jati)				16
Chili processors (Jakarta, Tanjung, Cirebon)				6

A total of 256 chili-growing farmers and 50 non-chili growing farmers were interviewed on management practices, input use, outputs and input-output prices, and marketing channels of chili, and one major competing crop of chili grown during the survey year. Sixteen market agents from Jakarta, Pedagang Pengumpul Desa, Karamat Jati and six chili processors from Jakarta, Tanjung, and Cirebon were also interviewed to understand the chili market systems and processing. In the production survey, the household member responsible for cooking for the family (for convenience they will be called housewives, regardless of their sex) were also interviewed on consumption patterns. Two hundred forty-three and 46 chili- and non-chili farmer-housewives and 62 urban housewives (mainly from Jakarta) were also interviewed to inquire about consumption of chili and other food items and preferred chili traits.

Macro Trends

Domestic Production

Chili production in Indonesia fluctuated from 581 to 1,102 thousand t, while area under chili varied from 143 to 183 thousand ha in 1991-2003 (Table 3). Chili production reached the record level of 1,067 thousand t in 2003 because of the increase in both area and yield. Sustaining such sudden jump in production may, however, be difficult.

The farm values of chili production were more variable than production, suggesting bigger fluctuation in farm prices. The maximum value reached US$929.4 million in 1999, more than double the value in the previous year. Similar fluctuations happened in the past such as in 1995 to 1996. These fluctuations are indications of unstable chili markets and lack of information by farmers about its potential demand.

Table 3. Area, production, and yield of chili in Indonesia, 1991-2003

Year	Area (ha)	Fresh production (000 t)	Yield (kg/ha)	Farm value (million US$)[1]
1991	168,061	984.2	5,856	482.4
1992	162,519	970.3	5,971	315.2
1993	157,499	946.2	6,007	374.7
1994	177,600	1,042.0	5,867	445.3
1995	182,263	1,102.3	6,048	469.1
1996	169,764	1,043.8	6,149	876.7
1997	161,602	801.8	4,962	820.2
1998	164,944	848.5	5,144	415.2
1999	183,347	1,007.7	5,496	929.4
2000	174,708	727.7	4,165	568.6
2001	142,556	580.5	4,072	428.1
2002	150,598	635.1	4,217	593.6
2003	176,264	1,066.7	6,052	676.3

Source: FAOSTAT database and official files of Agricultural Statistics Office, Jakarta.
[1]It was estimated using the FAOSTAT-Agriculture (producers' price) data. The prices in local currency were converted using the exchange rate reported in www.fftc.agnet.org (various issues).

International Trade

The total trade (import plus export) of Indonesia gradually increased from 5.9 thousand t (fresh weight chili) worth US$1.2 million in 1991 to a record of 32.5 thousand t worth over US$5.1 million in 2002, then experienced a decline in 2003 (Table 4). Throughout these years, however, the country generally remained in deficit in chili trade, as quantity and value of imports were higher than the corresponding values of export. The trade deficit reached its maximum in 2002 when the country had a net import of over 26,000 t of fresh weight costing US$3.3 million. The import of chili has risen from just 5 thousand to over 29 thousand t, while export increased from 0.8 thousand t to 3.3 thousand t in 1991-2002. Both import and export declined in 2003, although export value was higher than import.

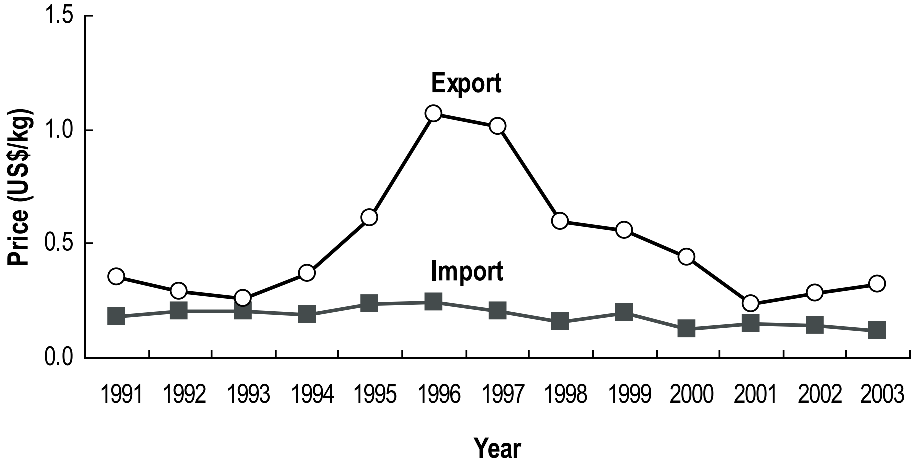
Indonesia is mainly an importer of pimento chili to be used for chili products, such as sauce and paste. Its share in the total imports (in terms of fresh weight and value) was over 87%. Indonesia also exports pimento chili, but its share in the total export ranged from around 54% to 98% in quantity and 36% to 96% in value from 1991-2003.

Indonesia exported high value chili and imported low-priced ones (Figure 1). The difference reached the highest level in 1996 when export prices reached its peak and then declined to its lowest level in 2001. Although there was declining trend in export prices since 1996, it remained higher than the import prices. Indonesia should try to bring its export prices significantly lower than its import prices to become competitive in the international market. To achieve this, the country needs to improve productivity in chili production and efficiency in its marketing system.

Table 4. International trade in chili from Indonesia, 1991-2003

Year	Import		Export		Total trade		Net trade balance	
	Quantity (t)	Value (1000$)	Quantity (t)	Value (1000$)	Quantity (t)	Value (1000$)	Quantity (t)	Value (1000$)
1991	5,188	936	753	264	5,941	1,200	-4,435	-672
1992	4,181	841	1,412	412	5,593	1,253	-2,769	-429
1993	11,430	2,309	1,438	368	12,868	2,677	-9,992	-1,941
1994	19,598	3,633	1,878	696	21,476	4,329	-17,720	-2,937
1995	6,382	1,519	2,862	1,742	9,244	3,261	-3,520	223
1996	7,826	1,914	2,834	3,037	10,660	4,951	-4,992	1,123
1997	16,695	3,374	1,607	1,631	18,302	5,005	-15,088	-1,743
1998	11,902	1,887	1,033	618	12,935	2,505	-10,869	-1,269
1999	13,290	2,620	2,506	1,392	15,796	4,012	-10,784	-1,228
2000	22,959	2,972	2,511	1,101	25,470	4,073	-20,448	-1,871
2001	26,241	3,970	4,190	1,000	30,431	4,970	-22,051	-2,970
2002	29,289	4,187	3,257	915	32,546	5,102	-26,032	-3,272
2003	26,418	3,031	2,890	924	29,308	3,955	-23,528	-2,107

Source: FAO-Agricultural data (Agriculture and Food Trade-Crop and Livestock Primary and Processed). The source reports the trade quantity of fresh chili and pimento as separate groups. The later was converted into fresh weight by multiplying it with a factor of four. The value of trade includes both for fresh and powder chili.

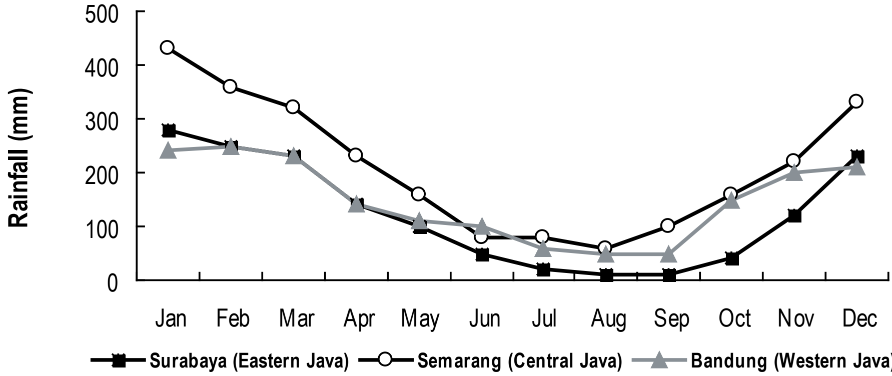


Source: Estimated from import and export quantity and value figures in Table 4.

Figure 1. Trend in import and export prices of chili in Indonesia, 1991-2003

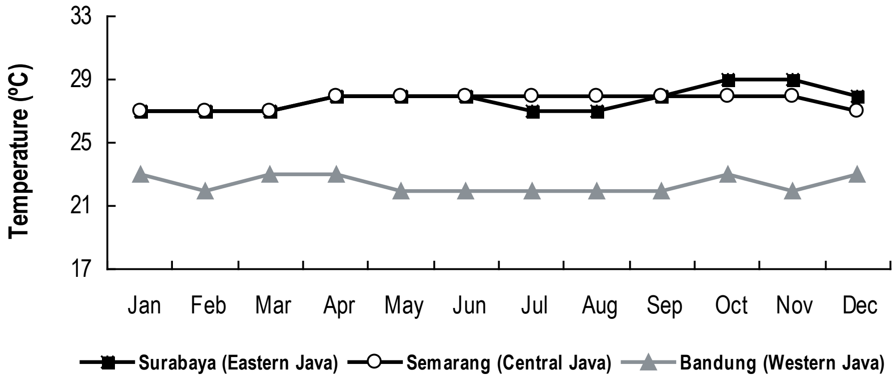
Climatic Situation

The climate of the study area is tropical with annual average rainfall ranges of 1480-1790 mm. Most of the rains come in November-March, while July-September is almost dry. The dry spell is longer and more severe in Surabaya of Eastern Java than in Central and Western Java. Central Java also experiences relatively higher rains during the rainy season compared to the other two sample regions (Figure 2a). In this study, November to April will be considered as wet season, and May-October as dry season for all sites.



Source: Downloaded from “http://www.weatherbase.com/weather/city.php3?c=ID&refer=” and then type city name

Figure 2a. Mean rainfall in the study areas in Indonesia



Source: Downloaded from "http://www.weatherbase.com/weather/city.php3?c=ID&refer=" and then type city name

Figure 2b. Mean temperature in the study areas in Indonesia

The temperature in Central and Eastern Java ranges between 27-29ºC, while in Western Java it is much cooler, ranging between 20-23ºC throughout the year (Figure 2b). The low temperature in Western Java is due to the high elevation of Bandung city (where temperatures are recorded) in Western Java. Therefore, upland chili production faces significantly low temperature compared to the production in lowland areas. Technology development for various ecoregion should take such differences in climatic situation into consideration.

Farmers Characterization

Socioeconomic Characteristics

While chili farmers were typically younger and had less farming experience than their counterpart non-chili farmers, they still averaged ten years experience of growing chili crop (Table 5). Interestingly, they have bigger family size, but no significant difference in the education level of the household heads of the two groups was observed. They had similar earnings from non-agricultural income as they spent almost the same time in agriculture as that of non-chili farmers. They also borrowed similar agricultural loans compared to non-chili farmers, as many of the non-chili farmers were vegetable or cash crop (such as cotton) farmers.

Table 5. Household characteristics of chili and non-chili farmers in the sample areas, Indonesia, 2002

Characteristics	Chili farmer	Non-chili farmer
Age of the farmer (years)	40[b]	45[a]
Agricultural experience (years)	15.1[b]	19.1[a]
Chili production experience (years)	10.3	-
Family size (no.)	4.54[a]	3.24[b]
Education (schooling years)	7.3[a]	8.8[a]
Farm size (ha)	0.56[b]	0.72[a]
Owned	0.36[b]	0.50[a]
Rented	0.20[a]	0.22[a]
Number of fragments (no.)	1.53[a]	1.35[b]
Off-farm income (000 IDR/year*)	2,717[a]	3,171[a]
Time spend in agriculture (%)	90.0[a]	89.1[a]
Cultivated area (ha)	0.49[b]	0.71[a]
Land use intensity (%)	94[b]	97[a]
Cropping intensity (%)	282[a]	177[b]
Chili area (ha)	0.38	-
Distance from paved road (km)	0.8[a]	0.7[a]
Distance from nearest vegetable market (km)	2.9[a]	3.2[a]
Agricultural loan (000 IDR/year)	1,568[a]	1751[a]
Farm equipments (average number)		
Small farm equipment	1.11[a]	1.37[a]
Water pump	0.2[a]	0.2[a]
Sprayer	1.3[a]	1.5[a]
Livestock (average number)		
Hen and duck	6.8[a]	6.7[a]
Cow	0	1.63
Animal (SAU**)	0.1[b]	2.0[a]

* One US$ = 9,012 IDR
** The standard animal units (SAU) was estimated as: SAU = 0.93 buffalo + 1.08 cow + 0.4 young stock.
Note: Different superscripts in a row imply that the values are different between chili and non-chili farmers at least at 10% significance level.

The farms of the chili farmers were smaller and more fragmented than that of the non-chili farmers. However, they allocated two-thirds of their farm area to chili. The typical field size allocated for chili production was 0.38 ha. No significant difference in the ownership of farm machinery was observed. The cropping intensity on chili farms was higher compared to non-chili farms, but land use intensity was almost similar. This was mainly because most chili farmers cultivated more crops at a time than the non-chili farmers implying that they were using shorter duration crops.

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House and Household Belongings

On average, three of every ten farmers keep one motorbike in their house, which was the main source of transportation between farms to their houses (Table 6). All non-chili farmer-respondents owned houses, while one percent of chili farmers were renting. A higher percentage of chili farmers had brick and cemented houses as compared to non-chili-farmers. Both groups had similar house covered area, although chili farmers had slightly larger total area of the house. The household belongings across the two groups were similar.

Table 6. Household living conditions and home appliances of respondents in the sample areas, by farmer type, Indonesia, 2002

Characteristic	Chili farmer	Non - chili farmer
House construction (%)		
Mud, local stone	11[b]	37[a]
Bricked, cemented	89[a]	63[b]
Source of drinking water (% of farmers)		
Government water supply	8[a]	8[a]
Private pump	37[a]	28[b]
Open well/artesian well/others	55[a]	64[a]
House covered area (m^2)	100[a]	87[a]
Total area of house (m^2)	192[a]	165[b]
Household belonging (% of farmers)		
Motor Bike	30[a]	40[a]
Car/pickup/jeep	5	-
Television	85[a]	94[a]
Radio and cassette player	100[a]	100[a]
Refrigerator	9[a]	2[a]
Stove	98[a]	88[a]

Note: Different superscripts in a row imply that the values are different between chili and non-chili farmers at least at 10% significance level.

Land Form, Drainage and Soil Texture

The soil texture reported by chili and non-chili farmers was almost similar (Table 7). On each farm type, the dominant soils were light. In the survey area, the majority of soils on chili and non-chili farms were well-drained, and the distribution with respect to drainage of land was not significantly different across the two groups. The majority of both chili and non-chili farmers were on flat land either on the riverbed or away from the riverbed side, and only a small percentage were on slope with and without terraces.

Table 7. Land form, drainage, and soil texture of farms in the sample areas, by farmer type. Indonesia, 2002

Character	Chili farmer	Non-chili farmer
Soil texture (%)		
Heavy	26	30
Medium	29	29
Light	45	41
Drainage (%)		
Well drained	45	38
Medium drained	34	35
Poorly drained	21	27
Land form (%)		
Slope with terrace	17	12
Slope without terrace	12	12
Plain on the river bed	36	28
Plain away from the river bank	35	48

Varieties and Cropping Pattern

Chili Varieties

In the sample area, three quarters of the chili parcels were planted with hybrid varieties, however, 34% of these were planted with the second year progeny of hybrid seed (F_2) (Table 8). The local and open pollinated (improved) varieties were grown only on 17% and 6% parcels, respectively, while only 3% parcels were found growing sweet pepper (hybrid). Similar distribution was observed based on area under different varieties. The hybrid chili was mainly concentrated in Central and West Java. The majority of the open pollinated and local chilies were grown in the Northern shore of Central Java. Sweet chilies were found only in West Java.

Among the hybrid chili-growing farmers the most popular variety reported was "TM999". The other common hybrid varieties were "Prabu", "Gada", and "Super". The most common local variety cultivated was "Segitiga" followed by "Helm" and "Titrandu". A substantial percentage of parcels (15%) were planted with unidentified "Local" varieties. In case of open pollinated, "Titsuper" was indicated as the most common variety followed by "Cakra", "Select Tam", and "Bendot". "Spartacus" (green-red) and "Gold Flame" (green-yellow) were the only two sweet pepper hybrid varieties reported by the farmers.

Table 8. Distribution of chili varieties grown in the sample areas, by region, Indonesia, 2002

Type	Name of variety	Percentage of parcels			
		West Java	Central Java	East Java	Overall (%)
Hybrid +		**38**	**52**	**10**	**75**
	TM999: Hung Nong/annum	80	20	-	43
	Prabu: East West/annum	-	100	-	22
	Gada:East West/annum	-	100	-	12
	Lado: East West/annum	-	100	-	4
	Taro:East West/annum	-	100	-	3
	CTH: Chis Tai/annum (wrinkle type)	100	-	-	2
	Super	-	-	100	8
	Others	50	21	29	6
Open pollinated (improved)		**11**	**67**	**22**	**5**
	Titsuper: East West/annum	-	-	100	52
	Cakra: Cakra Hijau	-	100	-	21
	Select Tam	67	33	-	21
	Bendot: annum	100	-	-	7
Local		**20**	**79**	**1**	**17**
	Segitiga	-	100	-	69
	Helm	-	100	-	10
	Titrandu	-	100	-	5
	Local (unidentified)	41	-	59	16
Sweet (hybrid)		**100**	**-**	**-**	**3**
	Spartacus: de Ruiter/green-red	100	-	-	75
	Gold Flame: de Ruiter/green-yellow	100	-	-	25

+ = Thirty four percent hybrid chili growing farmer used his or her own produced seed.

Note: The percentages for different varieties within one chili type add up to 100. The percentage of the four chili types adds up to 100. The regional distribution of each variety adds up to 100. Total number of parcels was 387.

Intercropping

In Indonesia, the majority of chili parcels (58.4%) in the sample area were intercropped mostly with one crop. A higher percentage of hybrid chili parcels were grown as a single crop compared to local chili, while all the open pollinated and sweet chili fields were single cropped. The hybrid chili was intercropped with shallot, tomato, and cabbage, while local type chili was mainly intercropped with red shallot (Table 9). Adiyoga et al. (undated) also found a large proportion of chili fields intercropped with similar types of vegetables. The extent of intercropping in their study varied from 38% to 97% in various regions.

Table 9. Intercropping (percentage of parcels) in the sample areas, by chili type, Indonesia, 2002

Intercrop	Hybrid	Open pollinated	Local	Sweet	Overall
Chili alone	28.3	3.5	6.7	3.1	41.6
Chili with one other crop	29.1	-	24.1	-	53.2
Tomato	10.6	-	1.6	-	12.2
Maize	0.8	-	-	-	0.8
Red shallot (onion)	11.0	-	21.3	-	32.3
Coriander	1.6	-	-	-	1.6
Cabbage	2.8	-	-	-	2.8
Other	2.3	-	1.2	-	3.5
Chili with two other crops	4.8	-	-	-	4.8
Tomato and onion	1.6	-	-	-	1.6
Tomato and other	2.4	-	-	-	2.4
Others	0.8	-	-	-	0.8
Chili with three other crops	0.4	-	-	-	0.4
Tomato, onion, and cabbage	0.4	-	-	-	0.4

Note: Total number of parcels was 387.

Crop Rotation

About two-fifths of the chili-growing farmers in the sample area practiced chili-fallow-chili rotation, and the majority of them cultivated a single crop in one year leaving the land fallow during one crop season (Table 10). However, some planted two chili crops in a year. The rest of the chili fields come with different crops in the rotation. Tomato and shallot were the most common crops cultivated in rotation with chili.

Table 10. Chili-based crop rotation in the sample areas, by chili type, Indonesia, 2002

Chili farmer	Crop rotation	Percentage of parcels
Hybrid	Shallot (RC*with chili) – Tomato – Shallot (RC* with chili)	3
	Tomato – Chili – Tomato	16
	Cabbage – Chili – Cabbage	5
	Corn – Chili – Corn	3
	Shallot – Chili – Shallot	7
	Chili – Fallow – Chili	46
	Other (RC* with chili) – Fallow – Other (RC* with chili)	9
	Chili – Other – Chili	11
Open pollinated	Shallot (RC* with chili) – Fallow – Shallot (RC* with chili)	51
	Onion – Onion (RC* with chili) – Onion	12
	Maize – Chili – Maize	12
	Paddy – Chili – Paddy	25

Cont...,Table 10

Local	Shallot (RC* with chili) – Paddy – Shallot (RC* with chili)	9
	Brassica – Chili – Brassica	11
	Cabbage – Chili – Cabbage	13
	Corn – Chili – Corn	14
	Paddy – Chili – Paddy	34
	Other crop– Chili – Other crop	9
	Chili – Fallow – Chili	10
Sweet (hybrid)	Chili – Fallow – Chili	100
Overall	Shallot – Chili – Shallot	6
	Chili – Fallow – Chili	40
	Other (RC* with chili) – Fallow – Other (RC* with chili)	15
	Tomato – Chili – Tomato	12
	Shallot (RC* with chili) – Other crop – Shallot (RC* with chili)	7
	Chili – Other crop – Chili	20

Note: Total number of parcels was 387.

* RC = Relay crop.

Cropping Pattern

About three-fourths of the area under all crops on chili-growing farms in the sample area went to vegetable cultivation including chili, while 28% of the area went to chili cultivation (Table 11). Percentage of the area under vegetables, including chili, was higher on chili farm than on non-chili farm. However, the latter group had higher proportion of area under other vegetables. The percentage of the area under cereals, beans and pulses, and commercial crops was higher among the non-chili farmers.

Table 11. Cropping pattern in the sample areas, by farmer type, Indonesia, 2002

Crop group	Chili farmer		Non-chili farmer	
	Area (ha)	Share (%)	Area (ha)	Share (%)
Chili	0.38	28	-	-
Other vegetables	0.61	44	0.69	55
Cereals	0.17	12	0.33	26
Beans and pulses	0.03	2	0.05	4
Commercial	0.11	8	0.18	14
Others	0.08	6	0.01	1
Total cropped area	1.38	100	1.26	100

Note: Cereals = paddy and corn; Beans and pulses = red bean, soybean, and peas; Other vegetables = shallot, tomato, cabbage, leaf onion, brassica, cauliflower, onion, egg plant, carrot, etc.; Commercial = potato, and groundnut; Others mainly are fruits such as papaya, banana, orange, mango, alpucat, jumbo, etc.

Cultivation Time

All sample chili farmers sow chili in nursery seedbeds, and later transplant the seedlings in the fields. Sample farmers reported variation in the sowing and harvesting time depending upon the mode of irrigation and type of chili. Chili is grown throughout the year in Indonesia (Table 12). The improved varieties of hot chili (hybrid and open pollinated) mature in shorter duration, especially because they have shorter harvesting span compared to local chili. In addition, these varieties had changed the cropping season of chili, which might enable the farmers to bring their outputs during the off-season and earn higher prices.

Table 12. Cultivation and harvesting time (week and month) by season and chili type, Indonesia, 2002

Chili farmer	Wet season			Dry season		
	Planting time	Start of harvesting	End of harvesting	Planting time	Start of harvesting	End of harvesting
Hybrid	1st Mar	1st May	3rd Jun	4th Jun	2nd Aug	3rd Oct
Open pollinated	-	-	-	1st Jul	3rd Aug	4th Oct
Local	3rd Jan	3rd Mar	2nd Jul	2nd Sep	4th Nov	4th Feb
Sweet	2nd Feb	2nd May	2nd Aug	3rd Oct	3rd Dec	4th Feb
Overall	4th Feb	1st May	3rd Jun	2nd Jul	1st Sep	2nd Nov

Information Source

Seed

The majority of farmers obtained seed-related information from neighboring farmers or friends followed by village retailers, extension workers and government seed centers (Table 13). The farmers growing sweet pepper got seed-related information from village cooperative and government centers. There was little connection between farmers and extension agents to supply independent information about seed quality.

Table 13. Source of information on seed and variety satisfaction of respondents in the sample areas by chili type, Indonesia, 2002

Chili farmer	Source of information about seed (%)[1]					Satisfaction (%)			
	Extension worker	Village retailer	Neighboring farmer	Gov. seed center	Others	High yield	Good price	Purity	All
Hybrid	2	14	57	8	7+	2	8	19	38
Open pollinated	-	-	22	11	-	-	-	-	44
Local	13	24	33	-	-	1	3	3	12
Sweet	-	-	-	38	62**	-	-	-	100
Overall	5	11	48	5	4	2	5	15	32

[1]The row sum of information source is not equal to 100 because some farmers do not use any information source.
+ Mixed source; ** Village co-operative

Overall, only a third of farmers were contented with their chili seed with respect to price, yield, and purity, while another 22% were satisfied with only one or another criterion. The remaining, about one-half of the farmers, were looking for better varieties. Users of local varieties were the least satisfied, while the growers of sweet pepper hybrids were completely contented. This analysis suggests that varieties with higher yield potential and better quality to fetch higher prices have high demand in chili-growing areas of Indonesia.

Market

Efficient marketing depends upon the access to accurate, appropriate, and timely information or intelligence. There was no formal source of market information for chili in the study area. Farmers obtained information mainly through private sources (Table 14). The major sources were traders and neighbor farmers ranked as the first and second most important information source, respectively. For the farmers using local varieties, neighboring farmers were the most important source.

Table 14. Market information sources and their rank by type of farmers in the sample areas, Indonesia, 2002

Chili farmer	Sources of market Information (%)						Rank					
	Trader	Neighbor farmer	Farmer asso-ciation	Govt. depart-ment	Radio	Other	Trader	Neighbor farmer	Farmer asso-ciation	Govt. depart-ment	Radio	News-paper
Hybrid	28	27	17	7	7	14	1	2	3	4	5	-
Open pollinated	45	35	15	10	10	0	1	2	4	3	-	-
Local	18	30	19	17	14	2	2	1	3	4	5	-
Sweet	29	33	19	9	0	11	1	2	3	4	-	5
Overall	32	30	14	6	4	14	1	2	3	4	5	-

Factors in Chili Variety Selection

The most important factor considered by farmers in the selection of red chili and sweet pepper varieties was the prices of the harvested fruit, while in green chili disease resistance was the main criterion. Market price in green, yield in red, and color in sweet pepper were the second most important criteria. Other less important factors in the selection of chili varieties are reported in Table 15.

Table 15. Relative ranking of factors considered in the selection of chili seed by farmers in the sample areas, by chili type, Indonesia, 2002

Factors	Green	Red	Sweet
Market price	2	1	1
Yield	4	2	4
Disease	1	-	5
Insect free	3	-	-
Appearance	-	-	3
Chili color	-	4	2
Flesh thickness	-	5	-
Pungency	5	3	-

Note: 1 = highest rank, and 5 = lowest rank.

Insects and Pests Problem

Insects

All the surveyed farmers reported insect as a problem in their fields. Overall, aphid, mites, and thrips were main insects reported by 26%, 23%, and 20% chili farmers, respectively (Table 16). Interestingly, the insects causing major problems varied across chili type. In hybrid cultivation, the highest ranking insects were thrips and mite, while mealy bug and aphid were major insects in local. Cultivation of sweet pepper under shades, houses/tunnels did not reduce the insect attack and all farmers reported the presence of all major insects, similar in other chili types, except mealy bugs.

Table 16. Major insects reported in chili fields in the sample areas, by chili type, Indonesia, 2002

Chili type	Farmers reporting insects as problem (%)						Rank[1]				Occurrence (years out of 5)		Average losses (%)	
	A	M	T	C	MB	Other	1	2	3	4	1993-97	1998-2002	1993-97	1998-2002
Hybrid	21	29	22	23	3	2	T	M	A	C	3.9	3.8	13	27
Open pollinated	36	11	16	5	31	1	T	A	M	C	4.4	4.0	9	34
Local	38	12	5	8	33	4	MB	A	M	T	3.8	4.7	8	17
Sweet	8	33	25	33	0	1	C	M	T	A	3.8	4.2	19	24
Overall	26	23	20	18	11	2	T	M	A	C	4.0	4.0	11	25

Note: A=Aphids (*Aphis gossypii* and *Myzus persicae*); C=Caterpillar (*Helicoverpa armigera* and *Spodoptera litura*); M=Mites (*Polyphagotarsonemus latus)*; MB= Mealy bug (*Planococcus* sp. and/or *Pseudococcus* sp) or White fly (*Aleurodicus dispersus*); T=Thrips (*Scirtothrips dorsalis*).

[1]The rank of 1 is the most devastating, and 4 the least devastating insect.

On average, severe attack of insects occurred four out of every five years, and this frequency was similar across chili varieties and did not change overtime. The yearly yield loss due to insect was highest at 34% in open pollinated varieties from 1998-2002, followed by the losses in hybrid and sweet chili types. The estimates of average yield losses due to insect attack increased from 11% in 1993-97 to 25% in 1998-2002. The major increase happened in hybrid and open pollinated varieties.

Diseases

Almost all farmers reported the infestation of diseases on chili fields. Overall, viruses, anthracnose, and Phytophthora blight were the major diseases reported by 37%, 27%, and 21% farmers, respectively (Table 17). Viruses were problems in all chili types; anthracnose infested a large number of hybrid fields, while Pytophthora blight heavily infested open pollinated and local chili types.

Overall, viruses were ranked to be the most devastating disease, and anthracnose got the second highest rank followed by Phytophthora blight and bacterial wilt. Viruses got the highest rank by all chili types except hybrids where anthracnose was given the highest rank. Open pollinated and local chili-growing farmers ranked Phytophthora blight as the second important disease, while hybrid chili and sweet pepper farmers gave second rank to viruses and anthracnose, respectively. The third and fourth ranking diseases for different varieties can be seen in Table 17.

Table 17. Major chili diseases in the sample areas, by chili type, Indonesia, 2002

Chili type	Farmers reporting diseases (%)						Rank[1]				Occurrence (years)		Average losses (%)	
	VR	AN	PH	BW	BS	OT	1	2	3	4	1993-97	1998-2002	1993-97	1998-2002
Hybrid	29	36	14	11	3	7	AN	VR	PH	BW	4	3.4	21	20
Open pollinated	48	5	42	5	0	0	VR	PH	BW	AN	4.1	3.4	35	50
Local	50	9	38	2	1	0	VR	PH	AN	BW	3.6	3.8	41	49
Sweet	54	21	12	0	13	0	VR	AN	BS	PH	5	4	25	-
Overall	37	27	21	8	3	4	VR	AN	PH	BW	4	3.6	29	38

Note: VR=Viruses; AN=Anthracnose (*Colletotrichum acutatum*, *C. capsici* and *C. gloeosporioides*); PH=Phytophthora blight (*Phytophthora capsici*); BW=Bacterial wilt (*Ralstonia solanacearum*); BS=Bacterial spot (*Xanthomonas campestris pv. Vesicatoria)*; OT=Other.

[1]The rank of 1 is the most devastating, and 4 the least devastating disease.

The average annual losses due to diseases of 29% reported by chili farmers in 993-1997 had increased to 38% in 1998-2002. The losses had increased in open pollinated from 35% in 1993-1997 to 50% in 1998-2002; it stayed at about 21% in hybrid, and increased from 41% to 49% in local chili during these years.

Weeds

All the sample farmers reported weeds in chili fields. A large proportion of farmers could not identify the weed present in their fields. The most commonly identified weed was *Cyperus sp.* reported by 31% farmers; its infestation was lowest in open pollinated and highest in hybrid chili (Table 18). This was followed by *Portulaca oleraceae* reported by 24% of farmers. Its infestation was highest in local and lowest in hybrids. Weed infestation was a regular phenomenon, occurring almost every year. Depending upon the variety, 14-18% losses were estimated due to weed infestation. The yield losses due to weeds increased overtime.

Table 18. Major chili weeds in the sample areas, by chili type, Indonesia, 2002

Chili type	Farmers reporting weeds (%)						Rank[1]				Occurrence (years during every 5 yrs)		Average losses (%)	
	TK	PO	AC	CD	UG	OT	1	2	3	4	1993-97	1998-2002	1993-97	1998-2002
Hybrid	36	13	10	7	18	16	TK	UG	PO	AC	5	5	10	15
Open pollinated	17	39	-	-	39	6	PO	UG	TK	-	5	5	11	14
Local	21	44	1	-	26	7	PO	TK	UG	-	5	5	13	18
Sweet	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Overall	31	24	7	4	22	13	TK	PO	UG	AC	5	5	11	15

Note: TK = *Cyperus sp.*; PO = *Portulaca oleraceae*; AC = *Ageratum conyzoides*; CD = *Cynodon dactylon*; UG = Unidentified grasses; OT = Other.
[1]The rank of 1 is the most devastating, and 4 the least devastating disease.

Farm Management Practices

Preparation of Nursery Seedling

Most chili fields were transplanted. However, some farmers sow seed directly in the field especially when it was planted as relay crop with shallot or onion. The chili transplant bed size was about 1-1.2 m long and 0.3 m wide covered with straw-mulch. In general they grow the seedling nursery near or within the vicinity of their house for protection and better irrigation access. The seedlings were transplanted when they are about five to eight weeks old, with height of about 10 cm and with 2-4 leaves.

Seed Treatment

Seed soaking before sowing was not common; only three percent of farmers, mainly in local and open pollinated chili types, practiced seed soaking for an average of 1.2 hours. More common was dusting of seed with chemicals practiced by 44% farmers. All farmers of sweet pepper and the majority of open pollinated and local chili reported treating the seed with fungicide before sowing it in the nursery bed. The main purpose of this treatment was to control 'dampling off' (Pythium). Only one third of the hybrid-growing farmers treated seed with chemicals expecting that it was already treated by the seed company (Table 19). The main chemicals used for seed treatment were Carbosulfan (insecticide) and Dithane (a fungicide). Similar frequency of farmers giving seed treatment was found by Adiyoga et al. (undated).

Table 19. Seed treatment by farmers in the sample areas, by chili type, Indonesia, 2002

Chili farmer	Farmer soaked the seed (%)	Duration of seed soaking (hrs)	Farmer applied chemicals to seed (%)	Chemicals applied (kg or l/ha)
Hybrid	2	1.1	33	0.01
Open pollinated	10	1	67	0.36
Local	8	1.5	74	0.35
Sweet	0	0	100	0.33
Overall	3	1.2	44	0.16

Nursery and Field Soil Treatment

A small percentage of farmers, only in hybrid and local chili types, applied soil treatment on chili nursery and main field to control the soil-borne diseases. In local chili, broadcast was the main method of soil treatment, while broadcast, placement and spray all were used for soil treatment in hybrid fields. Average per ha quantity of chemicals used in the field was 48 kg/l. The chemical used in nursery field was 2.4 kg-l/ha in case of hybrid and 17.5 kg-l/ha in case of local chili (Table 20). The main chemicals used for field soil treatment was Furadan (a fungicide) and for nursery Furadan and Sulfur (used to fumigate the soil to control insects and diseases).

Table 20. Nursery and field soil treatment in the sample areas by chili type, Indonesia, 2002

Chili type	Method of soil treatment (%)			Stage of treatment (%)		Quantity applied/ha (kg/lit)	
	Broadcast	Placement	Spray	Nursery	Field	Nursery	Field
Hybrid	11	5	7	14	9	2	48
Open pollinated	0	0	0	0	0	0	0
Local	7	1	5	5	8	18	51
Sweet	0	0	0	0	0	0	0
Overall	9	4	6	11	8	4	48

Land Preparation

The main means of land preparation was manual labor. Only 14% used power tiller or tractor. Adiyoga et al. (undated) found only three percent of the chili fields plowed by tractor. Farmers mostly applied single plowing including planking/leveling and seedbed preparation. Harrowing was done three to five times (four on average) during the season to control weeds. As sweet pepper was cultivated under hydroponics system, land was prepared and leveled only once without any plowing (Table 21).[1]

Table 21. Land preparation method in the sample areas, by chili type, Indonesia, 2002

Chili type	Percentage of parcels								Number of operation	
	Plowing				Harrowing				Plowing	Harrowing
	Hand	Animal	Power tiller[1]	Total	Hand	Animal	Power tiller[1]	Total		
Hybrid	78	9	13	100	96	1	3	100	1	4.7
Open pollinated	88	0	12	100	98	0	2	100	1	3.1
Local	80	0	20	100	98	0	2	100	1	3.6
Sweet[2]	-	-	-	-	-	-	-	-	-	-
Overall	79	7	14	100	96	1	3	100	1	4.4

[1] Including tractor.
[2] All sweet chilies in the sample were cultivated under hydroponics system.

Bed Types

A large majority of farmers grow chili on raised beds and only five percent used furrows; all sweet pepper fields were flat because they were in the hydroponics system. On average, furrows or raised beds were of 34 cm height and 118 cm wide (Table 22). The crop was planted in double rows with 59 cm average distance between rows and 43 cm average distance between plants within a row. The plant-to-plant distance was equal and highest in the case of hybrid and sweet chili types, but lowest and equal in local and open pollinated types. The sweet pepper farmers reported the largest row-to-row distance, while other varieties had almost similar distance.

Table 22. Bed types, height, width, plant-to-plant and row-to-row distance of chili in the sample areas, by chili type, Indonesia, 2002

Chili farmer	Bed type (%)			Furrow or raised bed (cm)			
	Furrow	Raised	Flat	Height	Width	Plant-to-plant distance	Row-to-row distance
Hybrid	7	92	1	34	103	51	57
Open pollinated	11	89	0	43	133	27	53
Local	3	97	0	35	128	27	57
Sweet	0	0	100**	0	0	51	119
Overall	5	91	4	34	118	43	59

** Hydroponics system.

[1]Hydroponics system is probably the most intensive method of crop production. It adopts advanced technology, is highly productive, skilled, and is often capital-intensive. Since regulating the aerial and root environment is a major concern in such agricultural system, production takes place inside enclosures that give control of air and root temperature, light, water, plant nutrition, and protect against adverse climatic conditions (Jensen, 1991). Plants are grown in nutrient solutions (water and fertilizers) via drip irrigation in a plastic green house type structure with the not reusable artificial medium (such as burned rice peal).

Mulching, Staking, and Shading

Use of plastic sheet as mulching material was very common among sweet and hybrid chili farmers, but less common for growers of local varieties. All sweet pepper fields were covered with plastic sheets in the hydroponics system while 64% hybrid fields were covered with plastic sheets as mulching material (Table 23). Twenty five percent of the open pollinated chili and only four percent local chili farmers reported the use of plastic sheet for mulching purposes. Straw as mulching material was also commonly used in the production of open pollinated and local chili types.

The majority of the sample farmers used silver black plastic sheets as mulching material. The life of plastic sheet ranged from 15 to 36 months with an average of 24 months or two succeeding croppings.

Table 23. Mulching material type and life span, in the sample areas, by chili type, Indonesia, 2002

Chili farmer	Type of material (% of farmer)		Type of foil (% of farmer)				Life of sheeting (month)	Staking (% of farmer)
	Plastic	Straw	Reflective	Silver black	Black	Other		
Hybrid	64	17	13	55	2	30	31	87
Open pollinated	25	66	50	-	-	50	36	25
Local	4	32	50	50	-	-	15	13
Overall	42	22	14	50	2	32	24	61
Sweet	100	-	-	100	-	-	24	100*

* String.

In the overall hot chili sample, 61% of farmers used staking to support the chili plant. This practice was more common in hybrids and sweet pepper than in other chili types. Only sweet pepper farmers used plastic shade houses made of bamboo to build the hydroponics system and used string while other chili farmers used bamboo as staking material.

Fertilizer Application

All the sample farmers applied inorganic fertilizer to their fields, and a great majority of them also used organic fertilizer (Table 24). However, none of the sweet pepper fields received manure because of their special production system. Poultry manure followed by mixed/compost and cattle manures were the main types used.

Generally, three applications of inorganic fertilizer split equally over the 3rd, 6th and 9th weeks after transplantation were applied to chili fields, regardless of variety. Some farmers also applied TSP (Triple Super Phosphate) with manure as basal application. A large proportion of the farmers also applied Zinc (Zn).

A great majority of chili fields were applied with fertilizer through placement method, and only a small proportion through broadcast or mixing fertilizer with irrigation. The sweet pepper farmers applied liquid fertilizer by mixing it with irrigation water in the hydroponics system.

Table 24. Organic fertilizer type and method of inorganic fertilizer application (% of parcels) in the sample areas, by chili type, Indonesia, 2002

Chili farmer	Organic fertilizer type				Method of inorganic fertilizer application			Inorganic application (no.)
	Cattle	Poultry	Mixed	Total	Broadcast	Placement	Irrigation	
Hybrid	9	45	33	87	10	67	23	3.1
OP[a]	-	33	22	55	11	89	-	3.4
Local	33	33	8	74	27	73	-	3.5
Overall	9	42	25	76	15	69	16	3.3
Sweet	-	-	-	-	-	-	100*	*

[a] OP - Open pollinated.
* Hydroponics system.

Irrigation

Majority of the chili fields received irrigation, and only 21% were rainfed (Tale 25). The major irrigation source was canal covering more than one-half of the chili fields. Tube wells/pumps and tanks (ponds, reservoir, lake) covered only a small area. In case of sweet pepper, water was stored in water tanks and later pumped through pipes. Irrigation sources were almost similar across all other chili types except that no tank and mixed sources were used in open pollinated fields.

Flooding was the main method of irrigation. In local and open pollinated chili types, it was mainly done in ridges, while in hybrid it was applied with and without ridges.

Table 25. Method and sources of irrigation in the sample areas, by chili type, Indonesia, 2002

Chili type	Irrigation method (% of parcel)					Irrigation source (% of parcel)				
	Flooding		Manual	Sprinkle+ trickle	Rainfed	Canal	Tube well	Tank/ lake	Mixed	Rain
	Without ridge	With ridge								
Hybrid	35	30	12	2	21	55	9	7	8	21
Open pollinated	21	44	13	-	22	67	11	0	0	22
Local	35	43	3	-	19	61	16	4	0	19
Overall	34	33	10	2	21	57	10	6	6	21
Sweet	-	-	-	100	-	0	0	0	100**	-

** Implies a method where water is stored in a tank and later pumped through pipe for irrigation purposes.

Insect Control

All the sample farmers applied insecticide to control insects in the chili fields. More than 35 different brands of chemicals were used to control chili insects; among the most popular were Curacron, Agrimec and Decis (Appendix 1). Some of these chemicals were not registered in Ministry of Agriculture (National Commission of Pesticides). A large majority of farmers applied mixture (cocktail) of insecticides and it was more common in case of hybrid and sweet chili. On average about two chemicals were mixed to make a cocktail.

The use of insecticide, according to farmers' opinion, was less than a perfect method of insect control; more than one-fourth of insect losses, according to farmers' perception, were not controlled despite using insecticide regardless of varieties (Table 26).

Table 26. Extent of insecticide use and their perceived effectiveness on chili in the sample areas, by chili type, Indonesia, 2002

Chili farmer	Farmer applying (%)		Number of chemicals mixed	Effectiveness (%)
	Single	Cocktail		
Hybrid	26	74	2.5	71
Open pollinated	45	55	1.9	78
Local	41	59	1.9	71
Overall	30	70	2.3	71
Sweet	0	100	3.2	75

Disease Control

Diseases were also a serious problem and got lots of farmers' attention as almost all sample farmers used fungicide to eradicate diseases in chili fields. Nearly 40 different types of chemicals were applied; the most common were Antracol, Dhithane and Curacron. Farmers used insecticides for the eradication of diseases (Appendix 1).

The fungicides were more specific compared to insecticide, as about one-half of chili parcels were treated with single chemical and the rest were given about three chemicals. On average, about three chemicals were used to make a cocktail. All sweet pepper parcels were treated with cocktails (Table 27).

The fungicides were even less effective than insecticide, as 36% of disease losses, irrespective of chili type, cannot be controlled through chemicals.

Both insecticide and fungicide applications continued until harvesting started. Less than one-half of the respondents wore mask or other protective clothing.

Table 27. Extent of fungicide and their perceived effectiveness on chili in the sample areas, by chili type, Indonesia, 2002

Chili farmer	Farmer applying[1] (%)			Number of chemical mixed	Effectiveness (%)
	Single	Cocktail	Total		
Hybrid	45	50	95	3.0	63
Open pollinated	55	33	88	2.5	70
Local	59	32	91	2.5	63
Overall	50	44	94	2.8	64
Sweet	-	100	100	3.2	66

[1]The sum of the two columns is not equal to 100 because some farmers were not applying chemical for disease control.

Weed Control

All chili farmers, except those who grew sweet pepper, practiced weeding. Almost all farmers applied manual weeding regardless of variety (Table 28). In addition, three percent of farmers applied herbicide while 21% used both manual as well as herbicide for weed eradication. No cocktail (mix of herbicide) was reported. Gramoxon, and Roundup were the most common products used to control weeds.

On average, farmers had four manual weeding operations and applied three chemical sprays to control weeds. However, some farmers applied as many as 12 weedings because of recurrence of weeds. The sample farmer of hot chili revealed that weeding was 76% effective, on average, with slight variation across varieties.

Table 28. Weeding, number, type and their perceived effectiveness in the sample areas by chili type, Indonesia, 2002

Chili type	Percentage of farmer			Farmers using weeding(%)	Weeding number		Effectiveness (%)
	Manual	Chemical	Manual+ chemical		Manual	Chemical	
Hybrid	77	4	19	100	4.3	4.3	76
Open pollinated	67	-	33	100	2.0	2.2	81
Local	74	-	26	100	3.4	3.0	75
Overall	76	3	21	100	4.2	3.2	76
Sweet	-	-	-	-	-	-	-

Other Methods of Pest Control

In the sample areas, about ten percent of farmers reported that sanitation, mulching, crop rotation, intercropping, early sowing, more picking, and weeding helped in controlling pests in chili field. However, the quantitative effectiveness of these methods was not indicated.

Adiyoga et al. (undated) found manual methods of controlling insects, such as removing the insect eggs, killing the insect, and removing the infected leaf/branch or even the whole plant, quite popular in their study area. According to the respondents in their study, the mechanical method of pest and disease control sufficiently helped when conducted at the right time. However, the method became ineffective when the attack intensity increases. Field observation, primarily to note the attack incidence and to estimate the intensity of attack was regularly conducted by most respondents. Nevertheless, this activity apparently tended to be followed by the decision to spray.

Harvesting

On average, farmers reported nine harvestings for hot chili. The highest number of harvest was for sweet pepper and lowest for open pollinated chili. Majority of farmers, regardless of chili type, combined family and hired labor in harvesting the crop. Only 11% of fields in hot-chili were harvested using only family labor, and ten percent using only hired labor (Table 29).

Table 29. Number of harvests and type of labor used (%) in chili harvesting in the sample areas, by chili type, Indonesia, 2002

Chili type	Number of harvest	Type of labor used (% of farmers)		
		Family labor	Hired labor	Both
Hybrid	10	12	13	75
Open pollinated	7	25	-	75
Local	8	8	4	88
Overall	9	11	10	79
Sweet	35	22	-	78

Marketing

Channels

Farmer sold chili output mainly to local trader/commission agents (72%), wholesale market at district level (17%), local market at sub-district level (7%) and farmer's associations (4%) (Figure 4). In case of sweet pepper, farmers sold all the products to their association, which was directly linked with a multinational company.

From the local trader, 74% of the chilies were directly sold to the wholesalers at the province level and the rest to the wholesalers at the district level. While the farmer's association sold to wholesalers at the district level, wholesalers at sub-district level, wholesalers based at Jakarta, local trader and directly to consumers. The local market at sub-district level sold 60% to retailer, 24% to wholesaler at district level and the remaining 16% to processors.

The wholesaler at the district level sold 85% to the wholesaler at the province level and rest to the processor. The wholesaler at the province level sold 48% to retailers and rest to processors (27%) and to the exporters (25%). The wholesalers in Jakarta sold 37% to retailers, 35% to vendors and 28% to chili processors. The processors sold the output mainly to the exporters (75%), and the remaining 25% back in the wholesale market. Retailers sold 65% to vendors and the rest directly to consumers. The vendor sold all chilies to the consumers (Figure 4).

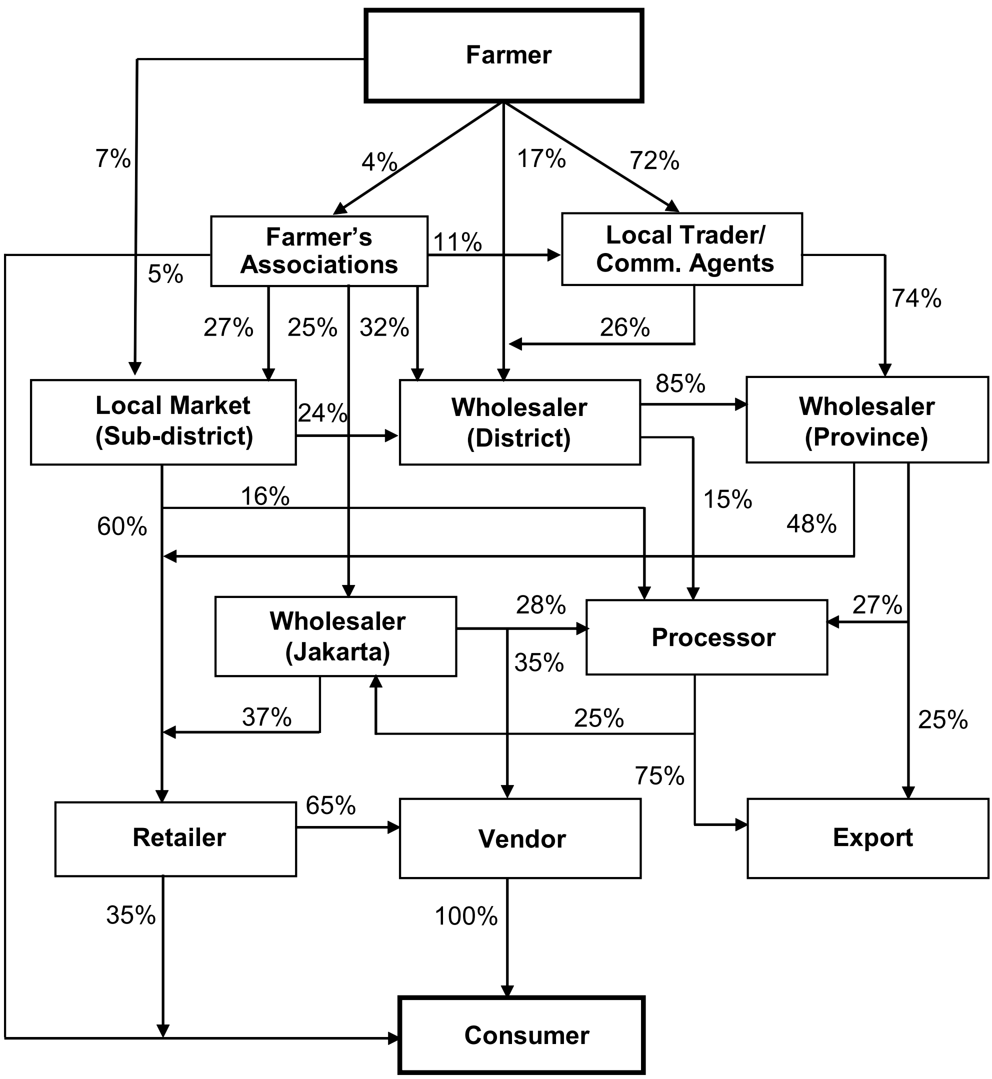

Figure 4. Chili marketing channels in the sample areas in Indonesia, 2002

Constraints

A large majority of farmers were not happy with the prevailing chili marketing system in the country, and only 15% were satisfied with the existing market structure (Table 30). Uncertain market prices were the major marketing constraint expressed by a large number of the farmers, while lack of price information and its unreliability and untimeliness, even if there was any, were the second major marketing constraints. However, low chili price was not a concern for a large majority of chili farmers.

About one-half of the sample farmers were not satisfied with the middlemen/commission agent's role. They complained about their exploitations in the form of low weighting, lower price, little premium for quality, and lack of grading system.

Table 30. Farmer's perception about constraints on chili marketing in the sample areas, Indonesia, 2002

Market constraints	Percentage of farmers
Price uncertainty	30
Lack of price information	19
No market problem	15
Exploitative role of middlemen	12
Low price	6
Weak bargaining power of farmer	3
No farmer organization	2
Others	13

Input Use

Seed Rate and Treatment

Eighty percent local and 56% open pollinated chili parcels were planted using home-produced seed, while all sweet pepper seeds were purchased (Table 31). Thirty four percent of hybrid-chili farmers used own-farm produced seed or they took it from neighboring farmers. Farmers applied higher seed rate for home-produced compared to purchased seeds, mainly because the former had better germination rate and purchased seed was usually taken better cared of before packing.

Higher seed rate was used to plant local and open pollinated compared to hybrid chili and sweet pepper. Special care was taken for sweet pepper nursery by applying more treatments to it. The higher seed rate for local and open pollinated types helped to refill the dead or weak seedling in the field.

Direct seeding was not practiced; seeds were first sown in the nursery and then transplanted in the field. Similarly, there was no practice of purchasing or selling of seedling. In a few cases, farmers shared seedling with neighboring farmers.

Table 31. Seed rate (kg/ha) in the sample areas, by source and chili type, Indonesia, 2002

Chili type	Seed rate (kg/ha)			Farmers using (%)	
	Self produced	Purchased	Average	Own-farm produced seed*	Purchased seed
Hybrid	0.91	0.26	0.48	34	66
Open pollinated	2.55	1.05	1.89	56	44
Local	1.48	4.95	2.17	80	20
Overall	1.29	0.86	1.07	49	51
Sweet	0	0.23	0.23	0	100

* Also include seed taken from neighbor farmer.

Fertilizer Use

On average, 8.7 t/ha organic fertilizer (manure) was applied to chili crop (Table 32). None of sweet pepper fields received manure. The highest amount of manure was applied in hybrid fields. Overall, about 279 kg/ha of all nutrients (from inorganic source including zinc) was used on hot chili. The amount of nitrogen was slightly higher than each doses of phosphorus, potash, or zinc.

Table 32. Fertilizer use in the sample areas, by chili type, Indonesia, 2002

Chili type	Organic fertilizer (t/ha)				Total fertilizer nutrient (kg/ha)			
	Cattle manure	Poultry manure	Mixed	Total	N	P	K	Zn
Hybrid	0.93	4.84	3.53	9.3	93	93	91	62
Open pollinated	0.00	2.76	1.84	4.6	67	40	52	19
Local	2.83	2.84	0.63	6.3	81	44	50	13
Overall	1.45	4.49	2.72	8.7	88	75	76	40
Sweet	0	0	0	0	187	104	112	0

The highest dose of inorganic nutrients was applied to sweet pepper followed by hybrids. The total nutrients applied to open pollinated and local chili types were similar, although the mix of nutrients was different. The farmers in the sample areas generally applied more than the recommended level of fertilizer to chili crop, which was 69 N, 36-54 P, and 60-90 K (DAE 2002).

Insecticide

On average, nearly 31 liters-kg/ha chemicals (single as well as cocktail form) were used to control insects in chili fields (Table 33). Farmers mostly mixed as many as seven different chemicals to prepare a "cocktail". About two-thirds of the total pesticide applied was in the form of cocktail. On average, 21 sprays of insecticide were applied on hot chili and 25 on sweet pepper in a crop growing season. The quantity of insecticide applied was relatively higher for hybrid chili and sweet pepper, but number of sprays was highest in open pollinated chili.

Table 33. Quantity of insecticide and number of sprays in the sample areas, by chili type, Indonesia, 2002

Chili type	Insecticide (Single)			Insecticide (Cocktail)			Overall insecticide applied (kg/ha)[a]	Number of spray
	Lit/ha	Kg/ha	Overall[a]	Lit/ha	Kg/ha	Overall[a]		
Hybrid	7.2	5.4	12.6	21.0	3.4	24.4	37.1	21
Open pollinated	12.0	0	12.0	17.0	0.0	17.0	29.1	29
Local	8.5	4.0	12.5	7.6	2.4	10.0	22.5	19
Overall	7.8	3.7	11.5	16.9	3.0	19.9	31.4	21
Sweet	0	0	0	20.7	14.6	35.3	35.3	25

[a] Liquid and solid pesticide were combined by assuming one liter is equal to one kg.

Fungicide

On average, 59 kg/ha of chemicals (liquid and powder) were applied to control diseases in chili (Table 34). The quantities of pesticide applied were highest for local chili and lowest for sweet pepper but the numbers of sprays was highest in open pollinated chili.

Table 34. Quantity of fungicide and number of sprays in the sample areas, by chili type, Indonesia, 2002

Chili type	Chemical (Single)			Chemical (Cocktail)			Overall pesticide applied (kg/ha)[a]	Number of spray
	Lit/ha	Kg/ha	Overall[a]	Lit/ha	Kg/ha	Overall[a]		
Hybrid	6.2	7.3	13.5	32.0	14.7	46.7	60.2	24
Open polinated	10.7	3.6	14.1	12.9	7.1	20.0	34.1	40
Local	8.2	7.2	15.4	32.0	14.0	54.0	69.4	39
Overall	6.6	7.1	13.7	31.2	14.2	45.4	59.1	29
Sweet	-	-	-	5.0	17.5	22.5	22.5	13

[a] Liquid and solid fungicide were combined by assuming one liter is equal to one kg.

Herbicide

On average, 1.63 kg/ha of herbicide (liquid and powder) were applied (Table 35). The quantities of herbicide as well as numbers of sprays were highest for hybrid.

Table 35. Quantity of herbicide and number of sprays in the sample areas, by chili type, Indonesia, 2002

Chili type	Overall herbicide applied (kg/ha)[a]	Number of spray
Hybrid	3.05	4.3
Open pollinated	1.69	2.2
Local	0.31	3.0
Overall	1.63	3.2
Sweet	-	-

[a] Liquid and solid herbicide were combined by assuming one liter is equal to one kg.

Irrigation

Overall, the chili fields received an average of 75 irrigations. The sweet pepper fields were irrigated with drip irrigation in the hydroponics system. Among hot chili types, the hybrid type received 82 irrigations, while open pollinated and local chili types received 67 and 58 irrigations, respectively.

Labor

On average, 345 labor days/ha were used for land preparation, crop management, harvesting, and post harvest operations of hot chili in the sample areas (Table 36). Sweet pepper utilized the highest labor (425 days/ha) and local chili the lowest (265 days/ha).

More than one-half of labor went to crop management activities, regardless of variety. Depending upon the variety, another 9-14% of labor went to land preparation, about 25% for harvesting, and another 6-7% for post-harvesting.

Table 36. Distribution of labor among different activity groups in the sample areas, by chili type. Indonesia, 2002

Chili type	Percentage distribution				Total labor (day/ha)
	Land preparation	Management	Harvesting	Post-harvesting	
Hybrid	12.6	56.0	25.3	6.1	385
Open pollinated	14.1	55.4	24.7	5.8	330
Local	13.3	54.9	25.4	6.4	265
Overall	12.9	55.5	25.4	6.2	345
Sweet (hybrid)	9.2	64.3	19.7	6.8	425

Credit

In Indonesia, only 21% of farmers had access to loan facility (Table 37). The major source of credit and loan was informal, mainly from relatives/friends, merchants, shopkeepers, etc. The average loan amount for hot chili farmers was IDR 656 thousand for a period of only seven months with 11% interest rate per annum. About 92% availed of loans to purchase inputs, while three percent purchased tractor/power tiller; only one percent used the loan to purchase machinery and the remaining four percent for other purposes which included marketing, social, construction of shed or tunnel, etc.

Table 37. Loan source, duration, interest rate and purposes by farmer type in the sample areas, Indonesia, 2002

Type of grower	Loan (% farmer)	Average loan (000IDR)	Sources					Duration (month)	Interest (%)	Purposes			
			Govt. bank	Friends & relatives	Merchants	Shop keeper	Others*			Input	Machinery	Tractor	Other
Hybrid	17	803	4	56	11	11	18	9	8	96	-	4	-
Open pollinated	11	11	-	-	100	-	-	6	10	100	-	-	-
Local	31	499	9	76	-	5	10	5	16	74	4	-	22
Overall	21	656	5	56	14	9	16	8	11	92	1	3	4
Sweet	25	26,250	100	-	-	-	-	24	13	-	-	-	100+

* Private bank, commission agents, etc.
+ Construct shed house and other material.

Sweet pepper production system was capital intensive. Therefore, farmers sought more loans for longer period for its cultivation than for other types: an average of IDR 26,250 thousand for the duration of 24 months. The major purpose of the loans for sweet pepper cultivation was for the construction of shed and other materials.

Production

Chili Yield

On an average, per ha yield of hot chili was 12.6 t in the sample areas (Table 38). Sweet pepper produced the highest yield with low coefficient of variation (CV). Among hot chili types, hybrids produced the highest yield but also gave highest CV. Variations in the management practices for hybrid type, which was relatively a new variety, explained high variation in its yield. Cultivation of F_2 and F_3 seed from previous years' crops also increased the CV. Overall yield of open pollinated and local varieties were similar, but the latter was more risky to produce as it has higher CV.

Table 38. Chili fresh yield (t/ha) by irrigation source in the sample areas, and by chili type, Indonesia, 2002

Chili farmer	Irrigated	Non-irrigated	Overall
Hybrid	17.9[a] (0.87)	9.4[b] (1.23)	13.9[b] (0.95)
Open pollinated	12.2[a] (0.53)	6.6[b] (0.73)	11.0[c] (0.61)
Local	11.2[a] (0.85)	3.0[b] (0.94)	10.0[c] (0.88)
Overall	15.6[a*] (0.82)	7.3[b] (1.35)	12.6[*] (0.91)
Sweet pepper	64.2 (0.69)	-	64.2[a] (0.69)

Note: Figures in parenthesis are coefficients of variation in yield.
The different superscripts across a row imply that the yields are significantly different across the two environments at the 10% level of significance. The different superscripts in the overall column imply that the yield is different across different chili types. The * in the overall row implies the statistical difference between the average of hot-chili types and sweet chili.

The yield of chili grown under irrigated condition was about double with a lower CV than the yield under rainfed condition. The yield of open pollinated and local types were similar but the latter had higher CV.

Yield and number of intercrops were negatively correlated, regardless of chili types (Table 39). The CV in yield also increased with higher number of intercrops. Although yield and number of intercrops were negatively correlated, the return to the production system including return from the intercrops were not.

Table 39. Chili yield (t/ha) by number of intercrops and by type of chili in the sample areas, Indonesia, 2002

Chili type	Number of crops intercropped				
	Zero	One	Two	Three	Overall
Hybrid	17.3 (0.86)	11.6 (1.02)	8.9 (1.55)	4.5	13.9 (0.95)
Open pollinated	11.0 (0.61)	-	-	-	11.0 (0.61)
Local	11.1 (0.81)	9.7 (0.89)	-	-	10.0 (0.88)
Overall	15.6 (0.84)	10.4 (0.95)	9.1 (1.09)	4.5	12.6 (0.91)
Sweet pepper	64.2 (0.69)	-	-	-	64.2 (0.69)

Note: Figures in parenthesis are coefficients of variation in yield.

One can perceive of a number of pros and cons of inter/multiple cropping. It reduces the risk of losses: in case one crop fails, revenues from other crops provide the buffer; seasonality in labor demand can be evened out; some crop rotations reduce pest attack; multiple cropping increases food security for small producer; cash-flow evened out and income from one crop can be a source of capital for the other, etc (Table 40). There are also some disadvantages of inter/multiple cropping such as cultivating more crop requires more knowledge and skill; labor planning become difficult if crops overlaps;

more capital and inputs are needed; number of pests may increase so does the risk of failure of individual crops, etc. The efficiency in land use and maintenance cost and reduced risk of obtaining additional income were cited as main reasons for intercropping by farmers in the Adiyoga et al. (undated) study.

Table 40. Advantages and disadvantages of inter/relay/multiple cropping as perceived by the authors

Advantages	Disadvantages
▪ Low prices or failure of one crop may not result in total loss (reduction in risk). Also provide food security for small farmers.	▪ The risk of failure of individual crop increases, although total risk of income from all crops in the system decreases.
▪ May be possible to keep labor employed for a longer time period, thus increasing the chances of obtaining the needed hired labor. ▪ Farmers become specialized in the cultivation of one crop, which improve efficiency in production.	▪ Labor planning and management may become more difficult if planting and harvesting period overlap for different crops. ▪ Growing more than one crop requires more management skills and knowledge about each crop's cultural practices.
▪ Some crop rotation may decrease pest build-up. ▪ More than one crop per year may be obtained from the same field. ▪ Low pre-harvest capital requirement crop may be used to provide cash for a high pre-harvest capital requirement crop	▪ Some crop rotation may increase pest buildup ▪ More than one crop may increase the amount of field machinery and /or packing equipment needed which would increase the capital investment requirement. ▪ Number of pest problems may increase.
▪ If using direct marketing, the ability to sell more than one product in the market might increases traffic to the market, generate repeat customers, and allow the market to stay open over a longer season.	

Chili Grades and Prices

The percentage of chili output produced according to different grade was estimated. Before presenting the results of the estimation, the specification of different grades are elaborated in Table 41.

Table 41. Specification of chili grades at the farm level in the sample areas, Indonesia

Grade	Quality	Characteristics
1	High	Fresh, highest number of seeds, long and straight, shiny and smooth surface, high fragrance, and dark red or green color.
2	Medium	Fresh, high number of seeds, medium size, clean surface, medium fragrance, and red or green color.
3	Normal	Average number of seeds, normal size, rough or wavy surface, little fragrance, light color.
4	Mix	Poor quality chilies mixed with different varieties.

The survey results suggested that majority of the hybrid chili marketed in the sample areas were of grade 2, while the majority of other chili types were of mixed grade (Table 42).

Table 42. Chili production grades and prices in the sample areas, by chili type, Indonesia, 2002

Chili farmer	Percentage of output				Price (000 IDR/kg)				
	Grade 1	Grade 2	Grade 3	Mix grade	Grade 1	Grade 2	Grade 3	Mix grade	Overall
Hybrid	5	56	3	36	7.10	4.80	2.00	3.50	4.36[b]
Open pollinated	12	11	11	66	7.00	3.50	1.50	2.50	3.69[c]
Local	5	17	22	56	5.00	4.10	2.00	3.03	3.08[c]
Overall	6	42	9	43	6.43	4.53	1.96	3.31	3.89*
Sweet	26	25	12	37	8.00	7.50	5.00	6.50	6.96[a]

Different superscripts in a column imply that the figures are statistically different at 10% level across chili type. The * in the overall row implies that average prices of hot-chili and sweet chili are significantly different.

The overall average hot chili prices received by the sample farmers were IDR 3,890/kg of fresh weight. The maximum price of IDR 6,960/kg was fetched for sweet pepper and the lowest of IDR 3,080/kg for local chili. The highest prices for hybrid chili among hot chili types were partly because of its quality such as attractive color and size, and partly because of the difference in the growing season. Open pollinated improved varieties were also grown during the off-season, therefore fetching higher prices than local type but lower than hybrids.

Economics of Chili Cultivation

Cost and Factor Share

The overall per ha total cost of production of hot chili was calculated at IDR 17.79 million and per kg output cost at IDR 1.30 thousands (Table 43). The respective total and per unit costs for sweet pepper were IDR 133.2 million and IDR 2.76 thousand, respectively. Total per ha cost of chili was significantly lower in case of local chili, but the per kg costs of local and hybrid varieties were statistically similar. Although total per ha costs of open pollinated and hybrid were similar, per kg cost of open pollinated varieties was higher than the hybrids because of the lower yield of the former.

The factor share of chemicals was highest in all hot chili types, while structures claimed the highest share in sweet pepper because of its peculiar production system that required large amount of initial investment on its basic infrastructural development. The lowest factor share of 4% of labor was found in sweet pepper production. In all hot chili types, the labor share ranged from 16-17% in hybrid and open pollinated to 23% in local chili. Fertilizer was the next important input, except in sweet pepper where irrigation share exceeded that of fertilizer. It is worth mentioning that seeds played the major role in productivity but had the lowest factor share, i.e., only one percent or less in case of local chili and sweet pepper, to two percent in hybrid and open pollinated chili types.

Table 43. Cost of production, factor share, cost per kg, and prices received in the sample areas, by chili type, Indonesia, 2002

Chili type	Cost of production		Factor share (%)						
	Total (000 IDR/ha)	Per unit output (000 IDR/kg)[1]	Labor	Seed	Fertilizer	Irrigation	Pesticide	Others[2]	Structures
Hybrid	19,742[b]	1.21[c]	17	2	13	12	39	12	5
Open pollinated	18,950[b]	1.83[b]	16	2	12	8	41	15	6
Local	13,725[c]	1.41[c]	23	1	16	5	31	15	9
Overall	17,791*	1.30*	18	2	14	10	37	13	6
Sweet	133,210[a]	2.76[a]	3.5	0.5	4	11	8	14	59

[1]Output cost is based on fresh form of chili.

[2] Others includes machinery cost, land rent, interest rate, taxes, and transportation cost.

Different superscripts in a column imply that the figures are statistically different at the 10% level across chili types. The * in the overall row implies that averages of hot-chili and sweet chili are significantly different.

Economics of Chili Cultivation

The per ha gross revenue from chili cultivation ranged from IDR 29.5 million in open pollinated to IDR 481.6 million in sweet pepper (Table 44). The highest revenue from sweet pepper was because of its high yield and price.

Net return from chili ranged from IDR 16.8 million/ha in case of local chili to IDR 348.4 million/ha in sweet pepper. The benefit-cost ratio was lowest for local and open pollinated chili types and highest for sweet pepper. Although open pollinated varieties had higher yield (difference was not significant) and higher prices compared to local chili, its higher production cost produced benefit-cost ratio similar to the local chili type. However, significantly higher yield and prices, despite higher production cost, gave higher benefit-cost ratio for the hybrid compared to the local and open pollinated chili types.

Table 44. Economics of chili cultivation in the sample areas, by chili type, Indonesia, 2002

Chili type	Gross return (000 IDR /ha)	Net return (000 IDR /ha)	B-C ratio (%)	Inputs productivity			
				Labor (000 IDR/ day)	Fertilizer (000 IDR/kg)	Irrigation (000 IDR/No)	Chemicals (000 IDR/kg)
Hybrid	69,360[b]	45,618[b]	251	171	197	817	614
Open pollinated	40,850[c]	20,900[c]	116	115	217	587	510
Local	29,541[d]	16,816[d]	115	100	145	497	274
Overall	54,999*	39,208*	209	150	188	710	526
Sweet	481,575[a]	348,365[a]	262	1,122	1,182	3,134	8,147

Different superscripts in a column imply that the figures are statistically different at the 10% level of significance. The * in the overall row implies that averages of hot-chili and sweet chili are significantly different.

Hybrid chili and sweet pepper production were capital intensive but generate generally higher benefit-cost ratio and resource use efficiencies compared with the other chili types. The benefit-cost ratio and labor, fertilizer, irrigation, and pesticide use productivities were all higher in sweet pepper than in hybrids.

Many farmers used home-produced hybrid seeds from previous years' F_2 and F_3 progenies to save on seed cost. The average yield per ha of F_1, F_2, and F_3 was 16.9 t, 8.5 t, and 4.5 t, respectively (Table 45). It is worth noting that the yield of F_2 is comparable with the yield of open pollinated and local types. The quality of the F_2 and F_3 output was also reduced as farmers obtained lower output prices thus further reducing the corresponding gross returns. Farmers also used less inputs especially fertilizer and pesticide, but partial input productivities were lower in both F_2 and F_3 compared to F_1.

The economics of F_1 and F_2 with respect to local and open pollinated varieties however was not as bad. In fact, net returns for F_2 were very similar to open pollinated, but higher than local varieties. Input productivities including benefit-cost ratio of F_2 were comparable or higher than local varieties, but lower than in open pollinated, except pesticide productivity. The F_3 seed produced lower return, benefit cost ratio, and input productivities compared to both open pollinated and local type varieties except pesticide productivity in local types.

Table 45. Economics of cultivation of chili in the sample areas, by hybrid type, Indonesia, 2002

Hybrid type	Gross return (000 IDR/ha)	Total cost (000 IDR/ha)	Net return (000 IDR/ha)	B-C ratio (%)	Inputs productivity			
					Labor (000 IDR/day)	Fertilizer (000 IDR/kg)	Irrigation (000 IDR/No)	Pesticide (000 IDR/kg)
Hybrid F_1	88,635	23,630	65,005	275	199	224	991	1978
Hybrid F_2	38,425	18,868	19,557	104	93	159	465	764
Hybrid F_3	17,892	11,761	6,131	52	42	114	256	416

Attraction and Constraints in Chili Production

Major Attraction

The profitability in chili cultivation was ranked as number one attraction in hybrid chili and sweet pepper, while tradition of growing chili was number one ranking attraction in open pollinated and local chili (Table 46). Other attractions in chili cultivation included personal motivation, experience in cultivation, and adaptability of the crop in local environment and cropping system.

Table 46. Ranking of attraction in chili cultivation in the sample areas, by chili type, Indonesia, 2002

Chili farmer	Profitable	Traditional	Well experience	Personal motivation	Well adopted	Others
Hybrid	1	2	5	3	4	-
Open pollinated	2	1	4	3	-	-
Local	2	1	3	4	5	-
Sweet	1	-	4	2	3	5*
Overall	1	2	4	3	5	-

* Availability of enough labor.
Note: 1 is the highest attraction; 5 is the lowest.

Major Constraints

Insects or diseases were number one or two ranking constraints in all chili types, except in local where low yield potential was the second-ranking and insects the third-ranking constraints (Table 47). It seemed that even in sweet pepper, where hybrid varieties were used, disease and insect resistance were not foolproof. Difficulty in marketing was ranked as third constraint in hybrid and open pollinated chilies, while in sweet pepper the high seed cost was ranked as third constraint.[2] Unstable environment was ranked as fourth constraint in all except hybrid types.

Table 47. Ranking of major constraints faced by farmers in the sample areas, by chili type, Indonesia, 2002

Chili farmer	Disease	Insects	High seed cost	Low yield	Environment	Market	Others
Hybrid	2	1	5	-	-	3	4+
Open pollinated	2	1	-	5	4	3	-
Local	1	3	-	2	4	5	-
Sweet	1	2	3	-	4	-	-
Overall	2	1	5	-	4	3	-

+ Low price
Note: 1 is the highest rank; 5 is the lowest.

Chili Processing

At the local and district levels, small processing units of the trader/commission agents were used to dry chilies before marketing. It is important to mention that all farmers in Indonesia sold chili in fresh form immediately after harvest. In the country, there were generally small chili-processing units, as well as very large multinational chili processing factories mainly for exports. Four chili grades were most common in Indonesia as indicated by processors (Table 48). Chili with dark red color, good pungency, less seeds, and of course without any infection were considered high grade. In their selection, small chilies with

[2]It should be noted that the ranking of seed cost constraints also connote the difficulty in getting modern seed varieties. In hybrid and open pollinated, the share of seed cost was two percent, while in sweet pepper it was only 0.5%. Despite this, the rank of seed constraint was lower in hybrid and open pollinated compared to sweet pepper because a significant proportion of farmers produced their own seed in the former.

high pungency, good fragrance, and lower prices were given first, second, and third rank, respectively. The chili entrepreneurs expressed their concerns about poor grading and quality of chili supplied by the farmers, price fluctuation, inadequate supply, and lack of capital. They also preferred to import chilies from India, China, Thailand, and Burma, which were cheap and of high quality.

Table 48. Dry chili grade in the sample areas, Indonesia, 2002

Grade	Quality	Characteristics
A	Super	Processed only fresh chili (mesocarp) without seed and stalk.
B	Medium	Processed fresh chili (mesocarp) without seed but there are still some stalk.
C	Normal	Processed whole chili (mesocarp, seed and stalk).
D	Mix	Poor quality chili processed with seed and stalk.

Chili Consumption

Per Capita Consumption and Expenditure

Overall, per capita weekly consumption of chili and its products converted into fresh weight was 185 g (Table 49). The consumption was higher among the chili farmers and their families than the other consumer groups. The "Sambals" (home-made crude chili sauce) was the major form of chili consumed in Indonesia. None of the respondents in the entire sample indicated consumption of dry or powder form of chili in cooking. However, in preparing ready-made noodles, some consumers made available powder chili as well as chili paste in the noodle's packet. Urban dwellers consumed substantially higher amount of chili sauce, a substitute for sambals, and "other" chili products than other consumer groups.

Table 49. Relative quantity share (%, converted into fresh weight) of different chili types in total consumption in the sample areas, by consumer type, Indonesia, 2002

Type of chili/products	Chili farmer	Non-chili farmer	Urban consumer	Overall[1]
Green	33.5	31.3	35.9	33.6
Red	54.6	43.8	34.4	39.3
Chili sauce	5.5	9.0	12.1	10.5
Chili dipping sauce	-	6.6	5.5	6.0
Other chili products	6.4	9.3	12.1	10.6
Total (g/week)	201.5	188.5	181.7	185.3

[1] Chili consumption in overall Indonesia was estimated assuming 1%, 50%, and 49% weights for the chili producer, non-chili producer, and urban consumer, respectively.

On average, Indonesian consumers spent about IDR 1,234/week on chili consumption (Table 50). Despite less quantity of chili consumed by urban consumers than their counterpart farmer groups, they spent more money on chili consumption, as they consumed more high-value chili products and purchased at the end of the retail marketing chain. While red fresh chili was the main product consumed on chili and non-chili farms, green and red fresh chili and chili products, including sauce, claimed almost equal share in the expenditure on chili by urban consumer.

Table 50. Relative share of expenditure (%) on different chili types in the sample areas, by consumer type, Indonesia, 2002

Type of chili/products	Chili farmer	Non-chili farmer	Urban consumer	Overall[3]
Green fresh	33	31	36	33
Red fresh	55	44	34	40
Other chili products[1]	12	25	30	27
Overall weekly per capita expenditure (IDR)[2]	949[b]	1,007[b]	1,472[a]	1,234

[1] Other chili products include grounded dry and processed chili products.
[2] The different superscript on the figures across this row implies that they are significantly different at the 10% level.
[3] The chili consumption in overall Indonesia was estimated assuming 1%, 50%, and 49% weights for the chili producer, non-chili producer, and urban consumer, respectively.

Retail Value of Chili and its Products

Expenditure divided by per capita consumption of chili multiplied by one thousand generated an average per kg price of chili and its products of IDR 6,659 at the retail level. This price was about 71% higher than the farm gate price of IDR 3,890 reported in Table 42. This ratio was used as factor in converting the annual farm gate value of chili production in Indonesia of US$676 million during 2003 (Table 1) into retail prices of chili and its product at US$1,157 million.

Demand Elasticity

An increase in the price of chili had very little effect on its demand. Even if prices were doubled the consumers would continue eating chili and there would only be a 13-14% decrease in the consumption of green and red chilies (Table 51). The decrease in chili products would only be around three percent. Conversely, a 50% reduction in chili prices would increase consumption of chili and its products by less than only two percent.

Table 51. Consumer response to changes in chili prices in the sample areas, by chili product, Indonesia, 2002

Change in price (%)	Percentage change in consumption		
	Green	Red	Product
Increase in price			
110	-4.19	-2.12	0
125	-4.59	-4.70	-0.07
150	-5.80	-5.58	-0.08
175	-7.62	-8.64	-1.98
200	-13.95	-12.71	-3.32
Decrease in price			
90	0	0.24	0
80	0	0.24	0
70	0.03	0.29	0.14
60	0.05	0.72	0.95
50	0.53	1.56	1.15

Chili Purchasing Source

Respondents purchased chili mainly from the local market or vegetable shops, followed by main markets and wholesale markets (Table 52). A significant portion of chili was also purchased from other sources especially by urban consumers, which included special day markets, superstore, or combination of different sources. For farmers, other sources included own-farm harvest, gift from friends, and others.

Table 52. Sources of purchased chili (% of consumer) by consumer and chili type in the sample areas, Indonesia, 2002

Chili type	Chili farmer				Non-chili farmer				Urban consumer			
	Local market	Main market	Whole-sale market	Other	Local market	Main market	Whole-sale market	Other	Local market	Main market	Whole-sale market	Other
Green	68	2	6	24	71	8	10	11	73	11	4	12
Red	54	3	4	39	68	9	12	11	59	9	6	26
Sweet	13	13	-	74	-	-	-	-	28	31	4	37
Chili sauce	65	19	12	4	72	27	-	1	50	3	14	33

Consumers' Preference for Chili Attributes

Urban consumers ranked freshness as number one characteristic in purchasing both green and red chilies (Table 53). The second factor considered for all green, red, and chili products was higher number of seeds. This may be because they prepared "Sambals" from fresh chilies and having more chili seeds made it hotter and tastier. Color was ranked as third among red chili and fifth for green chili. For chili product, hotness was the most important factor, and market prices got the third rank; fragrance and packaging of chili products scored fourth and fifth ranks, respectively.

Table 53. Factor considered in the purchase of chili by urban consumers in the sample areas, Indonesia, 2002

Characteristics	Overall rank		
	Green	Red	Product
Freshness	1	1	-
Number of seeds	2	2	2
Market price	-	-	3
Packaging	-	-	5
Disease/insect free	3	4	-
Color	5	3	-
Fragrance	-	-	4
Pungency	4	5	1

Note: Highest rank = 1 and lowest rank = 5

Consumers' Preference for Packaging

Majority of consumers preferred unpacked green/red chilies or in paper package mainly because of their high consideration for freshness (Table 54). They also preferred sweet pepper unpacked or in paper packaging mainly for freshness, cheap price, number of varieties available in paper packaging, and visibility of quality. In case of chili product the most preferred packaging was in plastic because it gave the best image of the product, and was ideal for active and modern people because of its convenience in storage and preservation, visibility, and cheap price.

Table 54. Consumer preferences for different types of chili packaging by chili type in the sample areas, Indonesia, 2002

Chili type	Packing type	Preference (%)	Main reason (% of consumer)						
			Freshness	Presentability	Cheapness	Variety	Ideal*	Visibility	Other
Green/red									
	Unpacked	44	92	1	1	-	-	2	4
	Paper	37	80	1	7	-	7	-	5
	Glass	9	14	28	-	-	-	1	57
	Plastic++	6	7	-	36	-	-	36	21
	Tin	4	-	-	-	-	25	-	75
Sweet									
	Unpacked	40	50	25	-	-	-	25	-
	Paper	32	-	-	25	25	50	-	-
	Plastic	24	100	-	-	-	-	-	-
	Glass	4	-	50	-	-	-	25	25
Product									
	Unpacked	16	-	-	-	-	25	75	-
	Paper	15	-	20	-	80	-	-	-
	Glass	10	6	35	-	-	-	-	59+
	Plastic	45	5	50	10	-	15	15	5
	Tin	14	-	-	-	-	100	-	-

* Ideal for active and modern people, + Good presentation, ++ Grocery 'bags' in various sizes.

Development Impact of Chili Cultivation

This section compared the development impact of hot chili and sweet pepper with rice and tomato.

Input Demand

The cultivation of chili, like other vegetables, was labor-intensive as it required many times more labor than rice. For example, hot chili production, which was less labor-intensive than sweet pepper, needed almost 2.6 times higher labor days than rice and about similar with tomato (Table 55). Sweet pepper cultivation engaged more labor than rice, tomato, and hot chili. In general, in vegetables and particularly in chili production, labor was engaged throughout the production period compared with other field crops. Therefore, expansion in chili area will generate employment opportunities in the rural areas.

The application of fertilizers on sweet pepper was also higher than in competing crops; the difference was significant when both hot chili and sweet pepper were compared with rice and tomato, but not significant when hot chili was compared with tomato. Similarly, the application of manure in hot chili was more than four times higher compared to rice and 74% higher than in tomato. Chili attracted more insects and pests than rice that was why it received more than 13 times pesticides spray than rice. It also needed many times more irrigation compared to rice.[3] Seed cost of both hot and sweet chili was also higher than rice and tomato.

Table 55. Relative per ha input use of chili and its competing crops in the sample areas, by farmer type, Indonesia, 2002

Crop	Labor (days)	Seed (000 IDR)	Fertilizer (Nutrient kg)	Manure (t)	Irrigation (number)	Pesticides spray (number)
Hot-chili	345^{b}	356^{b}	239^{b}	8.7^{a}	75^{b}	53^{a}
Sweet pepper	425^{a}	666^{a}	403^{a}	0.0	149^{a}	38^{b}
Rice	132^{c}	126^{d}	169^{c}	2.0^{c}	18^{d}	4^{d}
Chili framer	125	112	156^{*}	1.0^{*}	14^{*}	4
Non-chili farmer	135	129	170	2.5	20	4
Tomato	350^{b}	274^{c}	215^{b}	5.0^{b}	66^{c}	15^{c}
Chili framer	356	312	236^{*}	6.0^{*}	72^{*}	18^{*}
Non-chili farmer	343	256	195	4.0	21	13

Different superscripts in a column of the rows of hot-chili, sweet chili, rice and tomato suggest that the value of the parameter is significantly different at the 10% level.

The * in the row of chili farmer suggests that the parameter value is significantly different from the non-chili farmer at 10% level.

However, generally higher input use for chili than rice was not true for local chili type. The low inputs used by resource poor farmers on local chili was mainly due to high cost of modern technologies, non-responsive varieties, and inefficient credit distribution system. In fact, the input use intensity in chili can be further increased if these inputs were available at low cost to local chili growers and if credit was financed through efficient financial institutions.

Chili farmers applied lesser inputs to their rice crop, but more inputs to their tomato fields compared to non-chili farmers.

Resource Use Efficiency

Farmers obtained higher gross and net returns for chilies than for its competing crops, although the differences in gross return between hot chili and tomato was not significant (Table 56). Both hot chili and sweet pepper required higher cost than its competing rice crop. However, net returns in hot chili were about 19 times the returns in rice. The benefit-cost ratio was more than four times higher in hot chili production compared to rice and 67% higher compared to tomato production. The resource productivity, such as for labor and fertilizer, was also higher in both hot chili and sweet pepper compared to rice production. However, fertilizer productivity in tomato was higher than in hot chili.

[3] Although number of irrigation applied on chili crop were higher than rice suggesting higher labor needs to operate these irrigations, quantity of water on chili may not be higher as rice needs continuous application of water during its growth cycle.

Interestingly, rice and tomato production by chili farmers was more efficient than by non-chili farmers. This was reflected by higher benefit-cost ratio in rice, and higher fertilizer and labor productivities for both rice and tomato produced on chili farms compared to those in non-chili farms. In rice cultivation, however, the difference in efficiency was not so great because many of the non-chili farmers grew highly profitable crops like other vegetables or cotton.

Table 56. Resource use efficiency in chili and competing crop cultivation in the sample areas, by farmer type, Indonesia, 2002

Crop	Yield (t/ha)	Total cost (000 IDR/ha)	Gross return (000 IDR/ha)	Net return (000 IDR/ha)	B-C ratio (%)	Labor productivity (000 IDR/day)	Fertilizer productivity (000 IDR/kg)
Hot-chili	12.6	17,791[b]	54,999[b]	39,208[b]	209	150	188
Sweet chili	64.2	133,210[a]	481,575[a]	348,365[a]	262	1,122	1,182
Rice	5.01	3,950[c]	6,012[c]	2,062[d]	52	36	24
Chili farmer	5.00	3,621*	6,000	2,379	66	38	27
Non-chili farmer	5.20	4,012	6,240	2,228	56	36	25
Tomato	13.21	21,439[b]	48,283[b]	26,844[c]	125	128	213
Chili farmer	15.56	26,731*	53,238*	26,507*	99	145	216
Non-chili farmer	12.78	21,371	43,895	22,524	105	113	211

Different superscripts in a column of hot-chili, sweet chili, rice and tomato rows suggest that the value of the parameter is significantly different at 10% level.

The * in the row of chili farmer suggests that the parameter value is significantly different from the non-chili farmer at 10% level.

Impact on Gender and Poverty

About 63% of the labor force engaged in hot chili production was composed of women (Table 57). Sweet pepper and hybrid chili production engaged higher female labor than do open pollinated and local chili types. The share of female labor was 89% and 85% in harvesting and post harvesting operations for hot chili, respectively, and similar or even higher proportions were observed in case of sweet pepper. Management activities seem to be equally shared by men and women, although it was higher for men in chili than in rice. The share of women was less than 50% only in land preparation, but still higher than rice. The study can therefore conclude that chili production is a female-gender friendly crop.

Table 57. Gender distribution of labor in chili and competing crop cultivation in the sample areas, by operation type, Indonesia, 2002

Chili type	Percentage distribution[1]									
	Land preparation		Management		Harvesting		Post-harvesting		Overall	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Hybrid	24.2	75.8	55.3	44.7	89.2	10.8	88.3	11.7	64.7	35.3
Open pollinated	33.4	66.6	54.4	45.6	85.7	14.3	84.9	15.1	59.2	40.8
Local	28.3	71.7	56.2	43.8	88.6	11.4	69.3	30.7	57.4	42.6
Overall hot chili	25.2	74.8	55.3	44.7	88.8	11.2	85.4	14.6	63.1	38.5
Sweet pepper	32.9	67.1	47.6	52.4	92.7	7.3	85.5	14.5	65.5	44.5
Rice	14.5	85.5	44.8	55.2	45.1	54.9	35.4	64.6	38.6	61.4
Tomato	26.1	73.9	54.2	45.8	82.2	17.8	24.5	75.5	57.2	42.8

[1]The distribution between male and female under each operation adds up to 100.

As modern chili varieties utilized higher labor, including female labor, increase in their share implied more employment and income for the poor segment of the population. The average farm holding by chili farmers were lower than the non-chili farmers. In general, they were less resourceful and had lower income; therefore, helping these farmers means helping the poor and the women, which will help in eradicating poverty in Indonesia.

Impact on Hired Labor

Chili cultivation required more outsourced labor than rice, thus expanding the labor market. Overall, 35% of the labor used in hot chili cultivation was hired, compared to 30% in rice (Table 58). The proportion of the hired labor was higher in modern varieties, like hybrid and open pollinated, compared to the local chili types. The proportion of hired labor was highest in post-harvest operation followed by crop management operations, and lowest in land preparation.

Table 58. Distribution of labor source by chili and operation type in the sample areas, Indonesia, 2002

Chili type	Percentage distribution[1]									
	Land preparation		Management		Harvesting		Post-harvesting		Overall	
	Family	Hired	Family	Hired	Family	Hired	Family	Hired	Family	Hired
Hybrid	70	30	40	60	65	35	20	80	65	35
Open pollinated	65	35	35	65	60	40	15	85	60	40
Local	73	27	70	30	60	40	90	10	69	31
Overall	70	30	45	55	64	36	32	68	65	35
Rice	60	40	35	65	80	20	70	30	70	30

[1]The distribution between family and hired labor under each operation adds up to 100.

Impact on Consumption

Overall, income as well as expenditures of chili farm families were less compared with urban and non-chili farm families (Table 59). Chili production was profitable and more efficient in using resources. However, other farms had bigger land area, and non-farm groups had higher incomes from various sources. Moreover, many of them planted other crops such as vegetable and cotton and these may be equally or more remunerative compared to chili. The gap between chili and non-chili farmer's income and expenditure can be reduced through the introduction of modern varieties and cost-efficient chili production technologies. There is a large room for the introduction of pest-resistant high yielding chili varieties. Chili farmers spent substantial amounts on pesticide, which can be saved.

Table 59. Monthly per capita household income and expenditure in the sample areas, by farmer and consumer type, Indonesia, 2002

Consumer type	Expenditures (000 IDR)		Average income (000 IDR)
	Food	Overall including food	
Chili farmer	93.9[c]	140.8[c]	248.0[c]
Non-chili farmer	142.0[b]	200.5[b]	357.6[b]
Urban consumer	174.1[a]	268.4[a]	502.7[a]
Overall	110.8	168.0	297.4

The different superscripts in a column implies that the figures are significantly different across consumer groups.

Overall, chili farmers spent less on food items compared with urban household and non-chili farmers, because of their overall lower income (Table 60). Interestingly, chili farmers consumed more vegetables as they had higher proportion of area under vegetable than non-chili farmers as shown in Table 11.

Table 60. Average daily consumption of different food, by consumer group in the sample areas, Indonesia, 2002

Food group	Quantity (g/capita)			
	Chili farmer	Non-chili farmer	Urban consumer	Overall
Cereals	374[a]	362[a]	331[b]	356
Livestock products	116[a]	132[a]	140[a]	136
Vegetables	210[a]	195[b]	189[c]	207
Fruits	91[b]	96[b]	116[a]	98
Seafood	80[a]	93[a]	105[a]	98
Others	134[a]	154[a]	168[a]	148
Overall	995[b]	1,032[a]	1,049[a]	1,022

The different superscripts in a row means that figures are significantly different across consumer groups.

Summary and Policy Implications

Chili is a high-value commercial vegetable crop in Indonesia. The semi-crushed fresh chili in the form of "Sambals" is an essential ingredient of the daily diet. In 2003, its farm value was estimated at US$676 million, and the retail value of chili and its products at US$1,157 million. Based on average chili area on each farm, over 463 thousand farm families are estimated to be engaged in its production, and it can be speculated that a similar number may be engaged in the processing and marketing activities. In view of the role of chili in providing livelihood to a large number of rural and urban households, this study provided a comprehensive overview of the production, consumption, and distribution aspects of chili in Indonesia.

Chili production is a labor intensive and small farmer activity in Indonesia. Chili farmers are younger with larger family size and smaller landholding than non-chili farmers. Being small landholders, they are engaged in more crop activities and possessed fewer animals, but attain higher cropping intensity compared to their non-chili counterparts.

Chili farmers allocated a substantial part of their land to chili (28%) and other vegetables (44%). Chili management practices in Indonesia were dominantly traditional and the institutional setup was not very conducive for its development. Nearly 60% of farmers obtained seed-related information from their neighboring farmers and village retailers. Connection between farmers and extension agents to seek independent information about seed quality was rather weak. A very small percentage treated nursery or field soil. A large majority of farmers cultivated their land manually. As alternative risk-covering mechanisms were not available, a large percentage (58%) used intercropping as a tool to cover risk, although the practice produced lower yield. To save high seed cost, a large proportion of hybrid seed (34%) was F_2 saved from the previous crop. Only one-fifth of the farmers availed credit, mainly from informal sources. At the same time, however, advanced sweet pepper cultivation system under hydroponics had all the ingredients of good crop management.

Large quantities of insecticides and fungicides were applied both as single and in cocktail form but with inappropriate brands and doses. The availability of a large number of pesticide brands in the market and the practice of making cocktail suggest that pesticide use was not targeted to specific disease or insect. Many pesticides were used as insecticide as well as fungicide; therefore, its effectiveness was very low. Despite high pesticide use, the average losses due to insects and diseases were as high as 63%. This worrying phenomenon was associated with the increase in losses overtime despite the adoption of modern chili varieties. All these made insect and diseases the number one constraint in chili production.

Farmers in Indonesia had quickly adopted modern varieties of chili. Among modern varieties, hybrids types were more common. These varieties brought along improved management practices, and revolutionizied the chili production system in the country. For example, a great majority of these fields had plastic mulching and were given higher number of harrowing. They were also given higher doses of fertilizer, pesticides/fungicides and irrigations. Partly due to better resistance and partly because of better pest management practices, the yield losses due to diseases were much lower in hybrid fields. The modern hybrid varieties also engaged more labor, especially women and hired, in different operations compared to other hot chili types.

All these management practices produced higher yield. This, along with better quality attributes in hybrid seed (which enabled farmers to fetch higher prices), made its production economically more viable than other chili types and competing crops. The benefit-cost ratio and resource use efficiency were generally higher in hybrid than other hot-chili types. However, underpinning financial constraints forced the farmers to use F_2 and F_3 of hybrids, which reduced quality, yields and economic viability. A less costly and low input-demanding improved open pollinated varieties could help small poor farmers. Although certain open pollinated improved varieties were available to the farmers, its economic viability was equal only to the local unimproved varieties. Low yield potential despite high input use resulted to low economic competitiveness of these varieties. Collaboration with appropriate international organizations can greatly help to improve efficiency of research institutes and enable them to develop open pollinated varieties with high yield potential and desired attributes.

Chili cultivation in Indonesia covers different agro-climatic and cropping system domains. Intercropping of chili with different crops adds into the complexity. There is a need to develop separate chili production recommendation packages for different domains. The extension services should demonstrate the application of judicious, timely, and proper doses of fertilizers and pesticides. Besides, there are a number of non-production constraints such as unpredictability of prices, lack of price information, and exploitation by middlemen. Strengthening market infrastructure and information network can help resolve these issues.

Improvement in chili production and distribution systems will benefit the poor segment of the farming community, especially women and hired labor. The efficiency of resources engaged in chili production was comparable, if not better, with high-value vegetables such as tomato but better than cereal crop such as rice. However, as chili is an integral part of Indonesian diet as suggested by low demand elasticity, expansion in chili production should be carefully planned. Incorporation of consumers' preferred traits in chili varieties as identified in this study (such as freshness, more number of seeds, attractive color, and pungency) will improve its price and enhance farmer income. Stabilizing chili production by developing pest-resistant varieties and reducing environment stresses can reduce risk in chili production which will provide benefits for small poor farmers. Reducing production cost through judicious use of inputs, especially fertilizers and chemicals will not only reduce the cash requirements and enable small farmers to engage in highly profitable chili cultivation, but can also reduce environmental costs. In order to meet the cash requirements of modern technologies, farmers' access to credit should be improved. In this connection, the role of government and non-government financial institutes, private lenders, traders, and farmer's association is critical.

The link of chili producers with the market was relatively poor in Indonesia. Most of the farm output was sold to the local traders and very little went directly to the wholesale market at the district or provincial levels. Traders, in the absence of sophisticated market infrastructure, provided farmers links to several markets. Moreover, they supply liquidity in the absence of appropriate financial institutions. But the involvement of middlemen in many agricultural functions reduced farmers share in consumers price. Therefore, improvements in market infrastructure and financial institutions can help farmers supply chili as desired by the consumers, and also improve their share in consumers price.

Indonesians consumed mainly fresh chilies; only one-fifth of total chilies consumed were in dry form. Farmers sold fresh chili while local traders/commission agents dried a part of purchased chili under sun at open places. Moreover, no chili processing activity was practiced at the farm-level thus reducing their capacity of holding output for a longer period. If farmers carry out these activities by themselves, their share in the retail price of chili will be increased and their negotiation power will be enhanced. The extension department and processing units should motivate farmers on these practices. Cooperative marketing can also improve farmers' negotiation powers. The successful operation of some cooperatives in certain areas needs to be upscaled in other areas.

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Appendix 1. Frequency of different insecticide and fungicide used on chili, in the sample areas, Indonesia, 2002

Brand name	Chemical name	Frequency		Brand name	Chemical name	Frequency	
		Insecticide	Fungicide			Insecticide	Fungicide
Agrimec	Abamectin	12.95	6.61	Polyram	Metiram	-	0.44
Rotraz	Amitraz	0.55	0.66	Metindo	Metomil	0.55	0.66
Brent	Barium hydrox-ide octahydrate	-	0.44	Pounce	Permethrin	1.65	0.66
Bulldock	Beta-cyfluthrin	2.38	1.10	Folirfos	Phosphite acid	0.37	0.44
Spontan	Bisultap	-	0.66	Daitona	Poksim	0.37	-
Baycor	Bitertanol	-	0.44	Sportak	Prokloraz	1.10	-
Derosal	Carbendazim	0.37	3.52	Previcur	Propamocarb hydrochloride	-	1.32
Daconil	Chlorothalonil	-	0.44	Curacron	Prophenophos	21.75	12.59
Dursban	Chlorpyrifos	6.95	4.85	Antracol	Propineb	2.93	16.42
Kuproxat	Copper oxysulphate	0.55	0.88	Castle	Protiophos	-	0.44
Matador	Cyhalothrin	0.55	0.44	Larvin	Thiodicarb	4.02	3.52
Arrivo	Cypermetrin	0.55	0.44	Dilkran	Unknown	0.37	-
Trigard	Cyromazine	1.10	1.10	Dvsh	Unknown	0.37	-
Decis	Deltamethrin	8.91	6.39	Hik Kwang	Unknown	4.96	1.76
Pegasus	Diafenthiuron	3.47	2.86	Kampung	Unknown	0.37	-
Score	Difenoconazole	1.28	-	Kavidor	Unknown	0.55	0.66
Proclaim	Emamektin benzoat	4.57	2.64	Ousban	Unknown	0.55	0.44
Thiotan	Endosulfan	0.37	-	Phitan	Unknown	-	1.98
Rubigan	Fenarimol	-	1.10	Pilaan	Unknown	-	0.66
Regent	Fipronil	1.65	0.66	Pitvan	Unknown	-	0.44
Confidor	Imidacloprid	3.29	0.66	Suks	Unknown	-	0.44
Dhithane	Mancozeb	4.02	15.30	Supergo	Unknown	2.56	1.98
Pilaram	Maneb	0.73	-	Vegsus	Unknown	0.55	0.44
Ridomil	Metalaxyl	-	0.66	Vitame	Unknown	-	0.44
Tamaron	Methamidophos	0.55	-	Unnamed	Unknown	2.19	2.42

- implies that the chemical was not used for the purpose specified in that column.