LABLAB BEAN (*Lablab purpureus* (L.) Sweet) IN INDONESIA:

Crop and Super Food, Potential for Soybean Substitute and Industry

FOREWORDS

Indonesia is an agricultural country and has long been known to be very rich in a diversity of genetic resources (biodiversity) of crops, including Lablab bean which has potential as food, especially as natural protein sources. In Indonesia, lablab bean is vary familiar as a local legume crop which has potential as raw material for substitution in making ‘tempeh (fermented soybean food product), which is very popular as source of protein for most population. This is because the lablab bean has a fairly high protein content and other nutrients that are quite complete, even equivalent to its content in soybean.

Lablab bean is included in "pulses", which has function as functional food which in the future will be increasingly needed by the community. Thus, I strongly support the publication of this book entitled “Lablab beans (*Lablab purpureus* (L.) Sweet) in Indonesia : crop and super food, potential for soybean substitutes and industry”. This is because it will add the reading material which will be of many benefits, especially for the community or parties interested in the development of various local legumes including the Lablab bean and the development of processed food products in Indonesia. In addition, this can not be separeted with the promotion for the utilization of pulses in other countries for its benefits for human helth together with the development of not only in food product industry, but olso in pharmaceutical industry. The contents of this book are quite comprehensive and easy for readers to understand because it is compiled using simple language but adequately address the desired goals.If the development of Lablab bean farming and its industry can the realized, it will not only provide increasing income for farmers, but also become a lever for industrial growth in the country.

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CHAPTER 1. INTRODUCTION

Indonesia has long been known very rich in diversity of genetic resources (biodiversity) of crops, including those having potential as food, both as source of carbohydrate and protein. One of the type of plant is the Lablab bean (*Lablab purpureus* L. Sweet). This crop belongs to local bean of legumes (Harnowo and Antarlina, 2022; Djaafar *et al*., 2019; Jayanti, 2019). As a local legume crop, the lablab bean has a fairly high protein content and other nutrients that are quite complete, even equivalent to its content in soybeans. According to Partohardjono (2001), the terminology of local legumes was identified as potential legumes.

Commodities of various local legumes, including lablab beans, are included in "pulses", which have function as functional food which in the future will be increasingly needed by the community. This is mainly related to its high fiber content, low fat content and glycemic index, and high content of antioxidant compounds (Subagio and Morita, 2008; Harnani, 2009; Nafi' *et al*., 2013; Djaafar *et al*, 2019; Istiani *et al*., 2015; Purwanti *et al*., 2019; Widaningrum *et al*., 2015), so that these foods are very suitable for diets for diabete peoples (Subagio and Morita, 2008; Nafi' *et al*., 2013). These aspects is important in relation to the prediction of The World Health Organization (WHO) that the number of people with diabetes mellitus (DM) in Indonesia in 2030 will reach 21.3 million people and will be ranked fourth after the United States, China and India among countries with the most diabetes sufferers (Anonymous, 2012). To further promote the benefits and importance of these pulses, FAO even designated 2016 as 'The International Year of Pulses' (Calles *et al*., 2019; FAO, 2019).

Utilization of a variety of local legumes (including lablab bean) as food ingredients, especially in Indonesia, is still very limited. It is not surprising that the lablab bean is still considered a neglected crop, even though this crop has the potential to be developed as a food ingredient, especially as a source of protein and food fiber for the community in the future. In addition, the development of this commodity also plays a very important role in increasing the welfare of the community, including farmers. Budiman *et al*. (1998) and Balitbangtan (2015) stated that local biological resources (including the lablab bean) have global potential. In relation to the matters mentioned above, the Government, through the Ministry of Agriculture, have encouraged the development and utilization of various local legumes, including the lablab bean, as an alternative food source, especially for the provision of relatively inexpensive vegetable protein for the community (Ministry of Agriculture, 2020). The Director General of Food Crops of the Ministry of Agriculture, Suwandi, at the Propaktani Webinar (Friday 28 January 2022) with the theme "The Potential of lablab beans in West Nusa Tenggara Province" stated that local food must be developed, including the cultivation of the lablab bean crop, needs to be increased (Anonymous, 2022b).

The development of the cultivation of lablab bean crop is very important in the framework of providing raw materials (lablab bean seeds) for making processed food products that are popular for the community. It is hoped that this will be able to increase the consumption of lablab beans as a variety of local beans, in order to increase food diversification, especially for local food consumption. It is also hoped that this will increase the Expected Dietary Pattern Score (“Pola Pangan Harapan”), especially for the component of legume consumption, which is until now it has been lower than expected. The two goals mentioned above (increasing the PPH score and diversifying local food) ultimately lead to: (a) improving people's nutrition, (b) reducing the dependency on soybean as main material for “tempeh and tofu” as most preferred staple food products by most population, and (c) increasing the added value of commodities as well as the income and welfare of the community, including farmers.

Based on historical records, the lablab bean is basically not a native Indonesian crop. According to Maass *et al*. (2010), this crop is strongly suspected originating from Africa, or India (Murphy and Colucci, 1999), which then spread to America and to various countries in Asia, including Indonesia. In a period of about 50 years, lablab bean have been included in an important agricultural commodity, especially for the livestock sector in Australia and America. According to Bullivant (1963 *in* Deb Nath *et al*., 2019), the lablab bean crop is even suspected of being the oldest cultivated plant in the world. However, so far there is no clear information regarding when the lablab been crop began to enter and be cultivated in Indonesia. Areas that are often cultivated by lablab beans in Indonesia are East Java, West Nusa Tenggara, and Central Java, especially on dry land (Utomo *et al*., 1992; Harnowo and Utomo, 1993; Pamungkas, Without Year; Azkiah *et al*., 2018).

Aside from being a food ingredient, the lablab bean crop has quite a lot of benefits, namely as a ground cover and green manure or soil fertilizer (Ispandi and Munib, 2002), and animal feed (Murphy and Colucci. 1999). As a food ingredient, it is known that the nutritional content of the lablab bean is quite high, especially its protein content, which reaches an average of 29.20%, so that it has the potential to be used as a substitute for soybeans in the manufacturing of tempeh and tofu because it has soybean-like characteristics (Antarlina, 2021; Jayanti, 2019; Purnomo *et al*., 2016; Hartoyo, 2008; Ginting *et al*., 2002; Wardani, 2016; Werdiningsih *et al*., 2018). This is in line with Yunindanova's statement (2022) that Indonesia needs to think about alternatives to soybeans. Based on the descriptions regarding the characteristics, benefits and potential of the lablab bean as mentioned above, it is very ideal to be proposed that the lablab bean is called as "crop and super food”, potential for soybean substitutes.

If the potentials mentioned above can be realized, supported by the availability of sufficient raw materials (lablab bean seeds) nationally, then this will greatly assist in overcoming the recent shortage of domestic soybean production, as well as contributing to reducing soybean imports. As it is known, the national demand for soybeans in 2022 for food is around 3.24 million tons (Pusdatin, 2020). while its availability from domestic production is only around 549.6 thousand tons, or less than 20% (Jayani, 2021). Therefore, the importance of various local legumes (including lablab beans) as a potential substitute for soybeans in Indonesia can not be doubted.

According to van der Measen and Somaatmaja (1992), there are about 22 different types of local legumes in Southeast Asia, 14 of which have been cultivated by Indonesian farmers, including: pigeon pea (*Cajanus cajan*), chickpea/horse nut (*Cicer arietinum*), lablab bean (*Lablab purpureus*), Koro/Kekara bean (*Marotyloma uniflorum*), Java bean/kratok (*Phaseolus lunatus*), cowpea (*Vigna unguiculata*), winged bean (*Psophocarpus tetragonolubus*), and sword bean (*Canavalia* sp.). According to Purnomo *et al*. (2016), in East Java the genetic resources of local legume crops consist of 10 genera covering 27 species.

Lablab beans have various common names in Indonesia and around the world, for example, kacang biduk kara lard, bado bean, kacang komak and kara wedus (Java), komak (Madura), kacang peda (Sunda), Lablab bean (English); Bataw (Philippines); kekara, kara-kara (Malaysia); pegyi (Burmese); thua phaep (Thailand); dâu van (Vietnam); bai bian dou (China), Fiji Mame (Japan), Feselgohne, Helmbohne (Germany), Dolichos bean (India), hyacinth bean, lablab, dolichos (UK), Dolique D'egypte (France), Lobija (Russia), Dolico Egiziano (Italy) (Murphy and Colucci, 1999; Stuart Jr., 2019). This diversity of names indicates the area that can be grown and the fact that this crop has been cultivated by farmers in various countries for a long time. According to Plantamor (2023), synonyms for lablab beans are : Dolicos lablab L.B, Lablab leucocarpos Savi, Lablab niger Medic, and Lablab vulgaris Savi. However, the facts show that the Indonesian Government (through the Central Bureau of Statistics) has not yet collected data on the area of production (by province and nationally), productivity, and national production. Besides, until now there has been no official released of the lablab bean variety by the government. The existence of varieties (in the form of Nucleous Seeds and Breeder Seeds) of lablab bean that have been officially released by the Government is the starting point for the development of this commodity in Indonesia.

This book is structured with the following systematic subject matter : Introduction (Chapter 1), Classification and Characteristics of crop (Chapter 2), Nutrition value and utilization (Chapter 3), Cultivation techniques for lablab bean (Chapter 4), Prospects for developing lablab bean in Indonesia (Chapter 5), and Conclusion (Chapter 6).

CHAPTER 2. CLASSIFICATION AND CHARACTERISTIC OFLABLAB BEAN

2.1. Classification of Lablab bean crop.

India is one of the centers of genetic diversity of the lablab bean. This crop has the characteristic number of chromosomes 2n=2x=22, 24; It is very popular to be cultivated as a herbaceous annual leguminosae vegetable, although basically, it can be an annual herb (Parmar *et al*., 2013). According to USDA (2014), the classification of lablab bean is as follows:

Kingdom	: Plantae – *Plants*
Subkingdom	: Tracheobionta – *Vascular plants*
Superdivisi	: Spermatophyta – *Seed plants*
Divisi	: Magnoliophyta – *Flowering plants*
Kelas	: Magnoliopsida – *Docotyledons*
Subkelas	: Rosidae
Ordo	: Fabales
Famili	: Fabaceae Lindi – *Pea family*
Genus	: Lablab Adams – *Lablab*
Spesies	: Lablab purpureus (L.) Sweet –*Hyacinthbean*

2.2. Characteristic of lablab bean crop.

In general, the lablab bean crop is shrubby, rather upright or spreading with a main stem length of 1.5-6 m. The stems are twisted, massive, cylindrical, internoded, and green or purple in color, and have a taproot system. The leaves are three (trifoliate) green, flat-brimmed, pointed leaf tip, leaf base rounded. The length and width of the leaves range from 5-15 cm x 4-15 cm. The flower of the lablab bean is stiff bunches in the leaf axils. The flower stalks are cylindrical in shape. The length of the flower stalk is between 13-15 cm. In one bunch of flowers consists of 1-5 flowers. Crown shaped butterfly, white, pink, red, or purple and short-stemmed rectangular and sparse hair. The stamens are flat and white in color with a length of 1-1.5 cm. The anthers are round and yellow in color. The pistil head is round and yellow in color. The shape of the pods varies, namely flat, bulging, straight and curved with a size of 5-20 cm x 1-5 cm. The pods are green and purple with kidney-shaped seeds with a size of 6-7 mm x 4-5 mm. Seed color is white, brown, purple, and black. (Heyne, 1987 *in* Azkiyah, 2017). In each pod there are 3-6 seeds. Seed weight varied between 20.5-23.5 g/100 seeds (Kasno and Triwardani, 1989). In general, the shape of the lablab bean crop is presented in Figure 1.

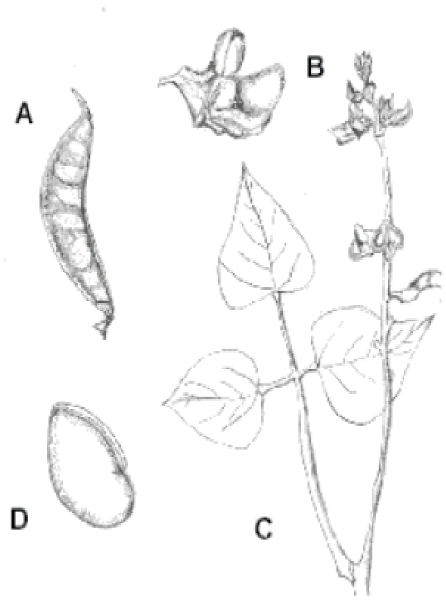


Figure 1. Diagram of parts of lablab bean crop.
Remark : A = Pod, B = Flower, C= Stem and leave, D = Seed.
Source : Murphy and Colucci (1999).

Information regarding morphology based on characterization, both qualitative and quantitative characters of lablan bean crop is not as much as that of other important crops. This is reasonable because until now the lablab bean crop has not become an important commodity in Indonesia. Morphological evaluation activities are very important in the framework of tailoring varieties of this commodity in the future. Many researches have done on characterization of morphology of the lablab bean crop, for example in Bangladesh and in India. In Indonesia, evaluation on the morphology of the lablab bean crop has been carried out on local lablab beans, for example those from NTB (West Nusa Tenggara).

The morphological characters of a crop besides being influenced by genetic factors are also influenced by environmental factors where it grows. According to Ridwan (2018), lablab beansgrown and adapted for a long time to certain agroecological conditions (for example in areas with dry and hot climates, as well as heavy soils), are likely to have different morphological characters compared to those long adapted to different agroecological conditions (e.g. in areas with a wet climate and light soil conditions).

Utomo *et al*. (1992) evaluated nine genotypes of lablab bean from Balitkabi Malang for qualitative and quantitative traits. All of the genotypesevaluated had a creeping growth type. Variations were found in hypocotyl color, flower color, seed coat color, plant height, flowering age, number of pods per plant, number of seeds per plant, seed weight per plant, 100 seeds weight, and seed yield per hectare (Table 1). Whereas Jayanti and Harisanti (2013) observed morphological characters of 13 germplasm materials of the lablab bean collected from various regions in Central Lombok Regency. It was found that there were variation in stem color, flower color, pod shape and color, color of the edge of the pod, indentation and texture of the pod, shape and color of the seeds, and the presence of spots on the seeds. Unfortunately, such observation was not followed by the quantitative characters. Quantitative characters such as 100 seed weight, number of seeds per pod, number of pods per plant, and seed weight per plant contribute to the yield potential of plant genotypes.

Deb Nath *et al*. (2019), have also observed several accessions of lablab beans in Bangladesh, with the following qualitative characteristics: round and oval seed shapes; light green seed color; light green hypocotyl color; green leaf bone color; green leaf color; white and purple flower color; dark green, purplish green and light green pod color; and slightly curved pod shape. Several quantitative characters of the accessions are : dry weight of 100 seeds 34.0-42.0 g; first flowering time 49.7-54.3 days; first harvest 75.7-85.0 days; pod length 9.0-10.2 cm; pod width 2.3-2.6 cm; number of seeds per pod 3.9-4.8 seeds; number of pods per plant 92.7-206.3 pods; weight per pod 4.6-5.8 g; seed weight per pod 0.43-1.16 g; pod weight per hectare 2.87-7.73 t/ha.

In India, Parmar *et al*. (2013) evaluated 30 genotypes of lablab bean for several quantitative characters. It is known that these genotypes have quite high quantitative characters variation. Furthermore, heritability analysis showed that the number of days up to 50% flowering, the length and width of the pods had high heritability. The correlation between seed yield and protein content of young pods was significantly negative. The average values and ranges of the observed characters are presented in Table 2. Complete information regarding the breeding aspect from the evaluation results is not presented in this book.

Ridwan (2018) also evaluated several local NTB lablab beans for stem, leaf and flower characters. The variation of stem characters is presented in Table 3 and those for leaf variation is presented in Table 4. Principally, those genetic materials with those variations are very useful for breeders for improving crop varieties. Unfortunately, until now there has been no effort to tailor a new high yielding (superior) variety of lablab beans formally by the goverment. An example of real leaf variation of lablab bean is presented in Figure 2; while the general visualization of the crop with immature and mature pods is presented in Figure 3, and the visualization in variation of seeds is presented in Figure 4.In summary, there are variations in the shape of the leaves of five local lablab beans. This shows that there are genetic differences for the five lablab beans from NTB in the shape of the leaves. The 'Kecipir' lablab bean is considered as the lablab bean with the most different leaf morphology as compared to the other four lablab beans (Figure 2).

Table 1. Summary of variation on qualitative and quantitative characters of nine assecions of lablab bean from Balitkabi Malang.

No.	Characters	Results of observation
1.	Growth type	Spread
2.	Hypocotyl color	Red, green
3.	Leaf type	Trifoliate
4.	Leaf shape	Heart
5.	Leaf color	Green
6.	Flower color	White, purple
7.	Seed coat color	White, black, brown
8.	Plant height	101 – 120 cm
9.	First flowering	75 – 80 days
10.	Mature pod	121 124 days
11.	Pod/plant	34 – 53 pods
12.	Seed/plant	18,1 – 30.5 seeds
14.	100 seed weight	21.1 – 23.5 g
15.	Seed yield	0.6 – 1.0 t/ha

Source : Utomo *et al*. (1992).

Tabel 2. The average and range value of quantitative characters of 30 genotypes of lablab bean from India.

Characters	Average value	Range value
50% flowerng (day)	98,68	39,33-147,33
First pod formed (day)	97,86	49,00-140,33
Pod ripening (day)	109,34	57,33-155,66
Pod/cluster (claster)	7.01	3,66-12,93
Pod length (cm)	8,53	5,18-10,48
Pod width (mm)	20,57	14,96-30,03
10 pods fresh weight (g)	45,36	27,66-64,33
Pod weight/plant (kg)	1,01	0,26-2,03
Number of pod/plant (pod)	234,84	63,33-497,66
Protein content (%)	19,84	16,26-22,13

Source : Parmar *et al*. (2013).

Tabel 3. Morphological characters (2,5 months after planting) of local lablab bean stem originated from West Nusa Tenggara (NTB), Indonesia.

Characters	**K1**	**K2**	**K3**	**K4**	**K5**
Leaf color	Deep green	Slightly yellow green	Deep green	Deep green	Deep green
Leaf bone color	Light green	Purple	Light green	Light green	Light green
Leaf stalk color	Light green	Deep purple	Light green	Light green	Light green
Leaf blade shape	Pentagon base-ends, equal	Round, thin base, fat tip	Round, thin base, fat tip	Flat, thin base, fat tip	Round, thin base, fat tip
Middle leaf shape	Taper, symetric	Rounded, symetric	Rounded, symetric	Rounded, symetric	Rounded, symetric
Middle petiole color	Light green	Deep purple	Light green	Light green	Light green
Middle petiole type	Forming triangle	Forming wide triangle	Forming wide triangle	Forming wide triangle	Forming wide triangle
Side leaf base type	Forming triangle	Forming wide triangle	Forming wide triangle	Forming wide triangle	Forming wide triangle

Remark : (1) Lablab bean ' Kecipir", (2)Lablab bean "Pangkes Ungu", (3) Lablab bean "Pangkes Ijo", (4) Lablab bean "Putik Lantan", dan (5) Lablab bean "Perseng".

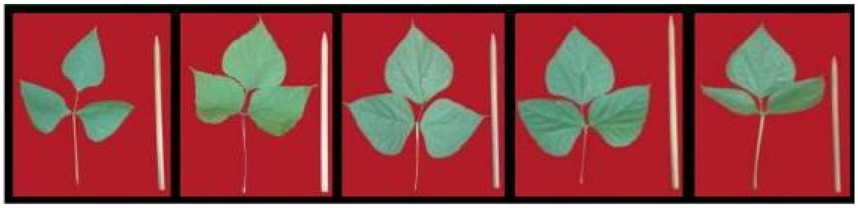
Source : Ridwan (2018).

Table 4. Qualitative characters of local lablab bean leaf from NTB.

Character	L 1	L 2	L 3	L 4	L 5
Stem color	Green	deep purple	green	Green	Green
Hairs on stem	Fine	Rough	rough	Rough	Rough
Shape of stem	Form a pentagon	Rounded	rounded	Form a pentagon	Form a pentagon
Stem segment length	13+1,67 cm	15+1,41 cm	13+1,26 cm	12+1,10 cm	15+1,36 cm
Stem diameter	0,25+0,05 cm	0,23+0,03 cm	0,25+0,02 cm	0,33+0,02 cm	0,36+0,02 cm

Remarks: L1= lablab bean' Kecipir', L2= lablab bean 'Pangkes Ungu', L3=lablab bean 'Pangkes Ijo', KL= lablab bean 'Putik Lantan', and L5= lablab bean 'Perseng'.

Source: Ridwan (2018).



(1) (2) (3) (4) (5)

Figure 2. Leaf morphology of local lablab bean from NTB (West Nusa Tenggara).

Remarks : (1) Lablab bean ‘Kecipir’, (2) Lablab bean ‘Pangkes Ungu’, (3) Lablab bean ‘Pangkes Ijo’, (4) Lablab bean ‘Putik Lantan’, and (5) Lablab bean ‘Perseng’.

Source : Ridwan (2018).

A B

Figure 3. The riil sample of lablab bean crop with young pods attached in plant.

Remark : A = Lablab bean with green color young pod, and
B = Lablab bean with purple color young pod.

Based on the great diversity of lablab beans in farmers' fields as have been discused earlier, in general it can be said that there is considerable genotypic variation in the existing local lablab beans. Those are very important as basic population material for plant breeders in tailoringg superior varieties of lablab beans in Indonesia. Furthermore, new superior varieties officially released by the government will be very useful for the development of lablab bean production in Indonesia through the production of Breeder Seeds, Foundation Seeds, Stock Seeds, and Extention Seed sufficiently.

1 2

3 4

Figure 4: Example of fisualization of lablab bean seeds with variation in seed coat color.

Remark: lablab bean with brown/purple (1), green (2), white (3), and black (4) seed coat color,

Source : 1 = Feedipedia picture, 2 = Susrama (2016),3 = Indonesian.alibaba.com, 4 = Littlespoon.farm

CHAPTER 3. NUTRITION VALUE AND UTILIZATION OFLABLAB BEAN

3.1. Definition and basic policy.

Before discussing the nutrition value and utilization of lablab bean in more detail, it is necessary to first convey the definition of nutrition, food, local food as well as several policies in order to increase local resource-based food consumption and its development. This is important, at least to encourage enthusiasm and without doubting in the utilization and development of food based on local resources, especially when it is associated with the trend of decreasing domestic production of vegetable protein sources, namely soybeans, which is the raw material for making tempeh, tofu, soy sauce, etc.

In the Food Law No. 18/2012 concerning food (Kemenhum-HAM, 2012), it was stated that food is the most basic human need and its fulfillment is part of human rights. This is very relevant with the 1945 Constitution of the Republic of Indonesia, namely food as a basic component for creating quality human resources. Furthermore, food is defined as everything originating from biological sources of agricultural, plantation, forestry, fishery, animal husbandry, aquatic and water products, both processed and unprocessed which are intended as food or beverages for human consumption, including food additives, food raw materials and other materials used in the process of preparing, processing and/or making food or drink (Food Law No. 18 Chapter I, Part 1, point 1).

In the Food Law No. 18/ 2012 it was also explained that local food is food consumed by local people according to local potential and wisdom. This definition is clearly very closely related to food based local resources. Meanwhile, nutrition is a substance or compound contained in food consisting of carbohydrates, protein, fat, vitamins, minerals, fiber, water, and other components that are beneficial to human growth and health. Processed food is food or drink that is processed in a certain way or method with or without additives. And, food diversification is an effort to increase the availability and consumption of food that is diverse, nutritionally balanced, and based on the potential of local resources.

In The Strategic Plan of the Ministry of Agriculture 2020-2024 (Kementan, 2020) it was also mentioned the need to increase affordability and utilization of food through efforts including : promoting food diversification with reference to diverse, nutritious, balanced and safe food consumption patterns. Based on that matters, increasing production and utilization of local biological resources (especially various local legumes) as food is very important. It was also stated that one of the strategy to agriculture reposition as a driving force for national development is to increase added-valued commodities and its competitiveness in fullfilling export markets and import substitution.

The above statementsare very important as a basis for policy makers and the public to make optimal use of the wealth of local genetic resources of legumes, including lablab beans, as a highly nutritious food ingredient, especially for tempeh, or at least for substitution for soybeans to be produced as tempeh. Since most of the demand for soybeans is for food (tempeh, tofu, etc.), it can be stated that these various local legumes commodities (including lablab beans) are at the same time as import substitutes commodity (in this case imported soybean). It was also stated that the development and utilization of various local legumes commodities is in line with and supports the efforts to anticipate adequate food supply related to climate change which is ongoing and may even be increasingly felt. Thus, one of the necessary strategies is to promote and positioning these various local legumes commodities (including lablab bean) as important and strategic commodities; if necessary, in an equal position with other food commodities. In this way, support for various aspects needed for the development of these commodities can be accommodated by policy makers.

3.2. Nutrition value of lablab bean.

The nutrition content of the lablab bean has been evaluated and reported for a long time. As a member of pulses group, the lablab bean has a fairly high nutrition content, even equivalent to soybeans (Table 5). In terms of seed protein content, Purwanti *et al*. (2019) reported that lablab beans from Madura contain higher protein than those from other regions. Compared to soybean, lablab bean contain much lower fat, but the food fiber and protein content is lower. The protein content of the lablab bean is still higher than that of the sword bean (*Canavalia ensiformis*) and other legumes, except for *Ficia faba*. Although the carbohydrate content is quite high compared to soybeans, pigeon peas, and other legumes, lablab bean has a low Glycemic Index (GI), which is 43.50. Reaffirming, as previously stated (Nafi' *et al*., 2006; Subagio and Morita, 2008; Nafi' *et al*., 2013) that the lablab bean is a functional food so that processed food based on the lablab bean is very suitable for the diet for people with diabetes mellitus (DM).

Lablab beans are also superior in fat content (lower) as compared to other local legumes, except for *Phaseolus calcaratus* and *Phaseolus angulatus*. In general, this shows that the lablab bean is a high-quality food source, especially related to the low fat content, so that it is a very good food source to be consumed by people with diet to reduce fat intake.

The amino acid composition of the PRFProtein Rich Flour) of the lablab bean is presented in Table 6. The highest type of amino acid in the PRF of lablab bean is glutamic acid (5.84%). The data is in accordance with the research results on several commodities, namely chickpeas, cow peas, lentils and green peas (Iqbal *et al*. 2006), sword bean and mucuna (Seena *et al*., 2005b, Agbede and Aletor, 2005). The lowest amino acid content (limiting amino acid) is methionine. This is because the lablab bean is a type of legume which only has small amount of sulfur-containing amino acids (S), namely methionine and cysteine.

Table 5. Chemical composition (%) of lablab bean, soybean, and several legumes/pulses.

General name	Botany name	Water	Protein	Fat	Karbo-hydrate	Fiber	Ash
Lablab bean	*Lablab niger*	9,6	24,9	0,8	60,1	1,4	3,2
Soya bean	*Glycine max*[1)]	9,4	39,9	15,8	19,0	4,5	4,0
Jack bean	*Canavalia ensiformis*	11,0	23,4	1,2	55,3	4,9	4,2
Pigeon pea	*Cajanus cajan*	10,1	19,2	1,5	57,3	8,1	3,8
Chickpea	*Cicer arietinum*	9,8	17,1	5,3	61,2	3,9	2,7
Kidney bean	*Phaseolus vulgaris*	11,0	22,0	1,6	57,8	4,0	3,6
Lima bean	*Phaseolus lunatus*	12,6	20,7	1,3	57,3	4,3	3,8
Rice bean	*Phaseolus calcaratus*	10,5	21,7	0,6	58,1	5,2	3,9
Adzuki bean	*Phaseolus angularis*	-	22,0[1)]	0,3	65,0	-	-
Green gram	*Phaseolus aureus*	9,7	23,6	1,2	58,2	3,3	4,0
Garden pea	*Pisum sativum*	10,6	22,5	1,0	58,5	4,4	3,3
Cowpea	*Vigna unguiculata*	11,0	23,4	1,3	56,8	3,9	3,6
Broad bean	*Vicia faba*	14,3	25,4	1,5	48,5	7,1	3,2
Winged bean	*P.*[2)] *tetragonolubus*	-	37,0	15,0	28,0	-	-
Lentil	*Lens esculenta*	11,2	25,0	1,0	55,8	3,7	3,3

Source: some data from Smartt (1976). [1)] : taken in avaerage value, [2)] : *Psophocarpus.*

Glutamic acid is an amino acid used to form proteins. According to Savitri (2020), in the body this amino acid is converted to glutamate. Glutamate itself is a chemical that helps the brain's nerve cells to send and receive information from other cells. In the medical world, glutamic acid can help overcome hypochlorhydria (less stomach acid) or achlorhydria (not producing stomach acid). Furthermore, this compound is also claimed to provide the following benefits:

a. Dealing with childhood personality or child behavior problems;
b. Helps treat epilepsy and muscular dystrophy;
c. Treating intellectual disorders;
d. Overcoming hypoglycemia (low blood sugar levels) in diabetics;
e. Prevents nerve damage in those undergoing chemotherapy.

Table 6. The composition and the content of amino acid in PRF of lablab bean.

Amino acid	% w/w ingredian	mg/g Protein
Aspartate acid	3,94	115,64
Glutamate	5,84	171,40
Serin	1,47	43,14
Histidin	0,97	28,47
Glisin	1,31	38,45
Treonin	1,07	31,40
Arginin	2,18	63,98
Alanin	1,41	41,38
Tirosin	0,99	29,06
Metionin	0,14	4,11
Valin	1,90	55,76
Fenilalanin	1,84	54,00
Isoleusin	1,75	51,36
Leusin	2,95	86,58
Lisin	2,06	60,46

Source : Nafi' *et al*. (2013).

Compared to carbohydrate dominant food source (white rice, which is 0.40 – 0.57% w/w) (Hermawan and Meylani, 2016), lablab bean contains relatively high dietary fiber (Table7). Dietary fiber is a component of plant tissue that is resistant to hydrolysis by enzymes in the stomach and small intestine. In other words, dietary fiber is part of the food that cannot be hydrolyzed by digestive enzymes. Based on several research results, as conveyed by the "Promkes RSST Klaten" Team (2022), some of the benefits of dietary fiber for health, namely:

1. Controlling Weight or Overweight (Obesity).
   Soluble fiber, such as pectin and some hemicelluloses, has the ability to retain water and can form a thick liquid in the digestive tract, so that foods rich in fiber take longer to digest in the stomach. Then fiber will attract water and give people a longer feeling of fullness, preventing people from consuming more food. Foods with high dietary fiber content usually contain low calories and low sugar and low fat levels which can help reduce the occurrence of obesity.
2. Help Reduce Diabetes.
   Dietary fiber is able to absorb water and bind glucose, thereby reducing the availability of glucose. Diets sufficient in fiber also cause the formation of complex carbohydrates and fiber, so that the digestibility of carbohydrates is reduced. This situation can reduce the increase in blood glucose.
3. Prevent Gastrointestinal Disorders.
   Adequate consumption of dietary fiber will give shape, increase water in the feces and produce soft and not hard feces so that only with low muscle

contractions the feces can be expelled smoothly. This has an impact on better and healthier gastrointestinal function.

4. Prevent Colon Cancer (Large Intestine).
   The cause of colon cancer is thought to be due to contact between cells in the colon with carcinogenic compounds in high concentrations and for a longer time. There is a hypothesis that if the consumption of dietary fiber is high, it will reduce the transit time of food in the intestine become shorter. And also, dietary fiber will affect the intestinal microflora so that carcinogenic compounds are not formed. Dietary fiber has the property of binding water so that the concentration of carcinogenic compounds bocome lower.
5. Reducing Cholesterol Levels and Cardiovascular Disease. Water-soluble fiber traps fat in the small intestine, so fiber can lower blood cholesterol levels by up to 5% or more. In the digestive tract, fiber can bind bile salts (cholesterol end product) and then excreted along with the feces. Thus dietary fiber is able to reduce cholesterol levels in blood plasma so that it is thought to reduce and prevent the risk of cardiovascular disease.

Table 7. The content of dietary fiber on several pulses.

Scientific name/ common name	Total fiber	Unhydrolized fiber	Hydrolized fiber
		(g/100 g of edible)	
Canavalia ensiformis (L) DC (Jack bean)	33,2 – 45,6	31,7 – 42,5	1,5 – 3,6
Canavalia gladiata (Sword bean)	21,0 – 22,0	20,0 – 21,0	0,02 - 0,8
Phaseolus vulgaris (“Bean”)	21,9	14,4	7,5
Phaseolus aureus (Green gram)	20,0	16,6	3,4
Phaseolus lunatus (Lima bean)	20,9	17,7	3,7
Vigna unguiculata (L) Walp. (Cowpea)	31,2 – 34,1	29,8 – 31,0	0,9 – 4,0
Lablab purpurea (L) Sweet (Dolichos)	42,0 – 48,0	39,9 – 44,0	2,1 – 4,0
Vigna radiata (L) Wilczek (Mung bean)	31,7	26,9	4,8
Cajanus cajan (Pegeon pea)	21,8	19,4	2,4
Glycine max (Soybean)	46,9 – 54,8	38,9 – 52,1	2,7 – 8,0
Stizolobium niveum (Mucuna)	42,7 – 45,0	39,8 – 41,0	2,9 – 4,0

Source: Esteban *et al*. (2017) from various sources.

Mineral and vitamin content of lablab beans and several other legumes is presented in Table 8. Lablab beans are superior in phosphorus (P) content compared to pigeon pea and winged bean, and superior in terms of potassium (K) content compared to cowpea and pigeon pea, and also superior in Thiamin content. compared to soybeans, cowpea, pigeon pea, and winged bean. For metabolic processes in the human body (Anonymous, 2022a), the P element plays a very important role in : (a) building and maintaining bones and teeth, (b) forming DNA and RNA, (c) helping muscles to contract, regulate the rhythm of the heart beat and transmits nerve signals, and (d) assists in the waste disposal process. Thus, P deficiency can exacerbate diabetes.

Potassium mineral is always associated with its role an electrolyte in the body (Anonymous, 2022c). Legume' seeds is one of the source potassium. Another benefits of potassium (K) for the health of the body, namely :

1. Lower blood pressure.
   Potassium (K) helps relieve tension in the walls of blood vessels so that it can lower blood pressure. K can also help reduce excess salt levels in the body by excreting it through urine.
2. Maintain the health of the heart and blood vessels.
   Adequate K in the body can prevent blood vessels diseases, such as high blood pressure, heart disease, and stroke, and can prevent narrowing of the arteries (atherosclerosis), and reduce the risk of heart rhythm disturbances (arrhythmias).
3. Maintain nerve function.
   The nervous system connects the brain and body. The brain sends messages to certain organs and body parts through electrical stimulation or impulses. Due to the performance of these nerves, the body is able to regulate muscle contractions and heart rate, as well as receive stimulation and feel pain (sensory function). If K levels in the blood are reduced, it can affect the brain's ability to generate nerve impulses. K deficiency in the long term can cause nerve and brain disorders, such as frequent pins and needles, forgetfulness, and muscle weakness.
4. Prevent kidney stones.
   K is able to bind Calcium (Ca) in the urine, thus preventing the formation of calcium mineral deposits which can become kidney stones. People whose daily intake of K is adequate have a lower risk of developing kidney stones than people who are deficient in K.
5. Maintain bone density.
   K plays a role in keeping Ca from being wasted through the urine. In addition, K can also increase the absorption of Ca in the bones, so that the bones do not lose their density (osteoporosis) and do not break easily.
6. Prevent muscle cramps.
   K deficiency can cause muscle cramps. Muscle cramps are a condition when the muscles contract suddenly and uncontrollably. Within the muscle cells, K helps relay signals from the brain that stimulate muscle contractions, as well as help end those contractions. When K levels in the blood are low, the brain cannot convey signals effectively, so the muscles continue to contract and cause cramps.

Another important compound in the seed of lablab bean is octanoic acid or caprylic acid (Julisaniah*et al*., 2022). This acid is a saturated fatty acid, as also found in Virgin Coconut Oil, cow's milk, and human milk (Novilla *et al*., 2017). Synonyms for this compoundinclude caprylic acid; n-Octanoic acid; neo-Fat 8; prylic acid. Caprylic acid has antibacterial,antiviral, antifungal, and anti-inflammatory properties, can prevent urinary tract infections,bladder infections, candida, herpes, oral infections such as gingivitis, and can protect the digestive and reproductive organs. Other benefits include strengthening the natural immune system, treating inflammation in the digestive tract, and also reducing the risk of antibiotic resistance (Novilla *et al*., 2017; Pubchem, 2021).

Table 8. Mineral and vitamin content in lablab bean and in several legume seeds.

Crops	Ca	P	Fe	Na	K	Cu	Zn	B-Kar	Thia	Ribo	Niasin
Lablab bean, dry seed	88	395	3,5	43	403,8	1,30	9,1	0	0,62	0,12	1,8
Soybean, dry seed	222	682	10,0	210	713,4	1,58	3,9	237	0,52	0,12	1,2
Vigna unguiculata, dry seed	481	399	13,9	15	7,8	1,03	5,9	65	0,06	0,20	4,3
Pegeon pea, dry seed	146	445	4,7	16	1306,2	0,99	2,7	19	0,30	0,19	2,4
Winged bean, dry seed	468	182	6,8	37	955,0	2,82	2,0	-	0,30	0,44	3,0

Remark : Tia = Thiamin; Ribo = Riboflavin. Unit : Ca, P, Fe, Na, K, Cu, dan Zn = mg/100g of edible; B-kar = mcg/100g of edible; Thiamin, Riboflavin, dan Niasin = mg/100g of edible.

Source : Ministry of Health Rep. of Indonesia (2017).

Include the Importance of lablab bean

3.3. Utilization of lablab bean.

Utilization of lablab beans as a food ingredient, especially as a raw material for tempeh, has not been much developed, even though based on research results, lablab beans can be used as a raw material for making non-soy tempeh (Ginting *et al*., 2002; Cahyani and Mardiatik, 2012; Balitkabi, 2017; Nurmadhani *et al*., 2017; Fahriani, 2019); even for various highly nutritious food products (Nafi' *et al*., 2006; Sukamto, 2013). The presence of anti-nutritional compounds in various local legume commodities (trypsin inhibitor compounds, phytic acid, tannins and HCN) for making tempeh can be overcome to a safe level by peeling the skin, soaking and boiling (Ginting *et al*., 2002; Shurtleff and Aoyagi, 1979 *in* Tsaqqofa *et al*., 2010). The utilization of the lablab bean in general include: vegetables, snacks, side dishes (tempeh, nuggets and sausages), and medicines

a. Lablab bean as vegetable in Indonesia.

As vegetable, it is mainly consumed in the form of young pods. According to Stuart Jr. (2019), young lablab bean pods consumed are a source of calcium (Ca), iron (Fe) and vitamin C. The utilization of young lablab bean pods does not only occur in Indonesia (Joko, 2010; Indrawati, 2019; Azkiyah, 2017; Harnowo and Antarlina, 2022), but also in several countries, for example in Bangladesh (Deb Nath *et al*., (2019), India (Parmar *et al*., 2013),Thailand (Anonymous, 2010), and the Philippines (Stuart Jr., 2019). Several examples of the form of vegetable dishes from young lablab bean in Indonesia are presented in Figure 5.

“Tumis” of young pods

“Sayur asem” of lablab bean

“Sambal” lablab bean

“Tumis” with long red bean

“Krecek” with coconut cream

Lablab bean “Meseroh”

Figure 5. Examples of vegetables made from lablab bean.
(Source: www.cookpad.com/id/resep/14741172-sayur-)

b. Lablab bean as snack.

Mature lablab bean seeds are often processed into lablab snacks which taste quite delicious and are popular in community. Small home-scale industries play an important role in this type of food business, thereby opening up employment opportunities, as well as having the potential to increase people's income and welfare. Products in the form of snacks also have considerable potential to be developed in tourist spots/location. Several examples of visualization of lablab bean snacks are presented in Figure 6.

“Emping” lablab bean

Fried lablab bean seed

“Lablab bean Sambal”

“Nano-nano seeds snack”

Gambar 6. Examples of snack made from lablab bean.
Source: www. shopee.co.id/Kacang-komak-sambal-khas-.

c. Lablab bean as side dishes.

In Indonesia, tempeh is commonly used as a side dish (Java: lauk paauk), although tempe is also often used as a vegetable (for example 'lodeh tempeh’). In fact, tempeh has been a food source of vegetable protein that is affordable (low price) for the community since the Dutch colonial era. In historical records, tempeh was originally made from soybeans. Even until now, the majority of tempeh is made from soybean grains, of which about 80% of the need is obtained from imports.

Lablab bean tempeh is one of the processed food products that is expected to be able to reduce dependence on soybeans which have been the basic ingredient for makingtempeh. The general terminology for tempeh, according to BSN (2015), is a product in the form of a white compact solid, which is obtained from peeled soybeans which have been boiled and fermented. The principle of making soybean tempeh basically also applies to the manufacture of tempeh made from non-soybeans (including lablab beans). So, the principle of making tempeh includes three stages, namely: (1) hydration and acidification of the seeds by soaking them for some time (in tropical areas approximately overnight), (2) heating the seeds, namely by boiling or steaming, and (3) fermentation by tempeh fungus/yeast. The fungus that is widely used is *Rhizopus oligosporus* At the end of fermentation, the material (in the form of seeds) will be compactly bound.

The fermentation process in the manufacture of tempeh causes the components of the bean to be hydrolyzed into compounds that are simpler and easier to digest. Processing various beans (including lablab beans) into tempeh will increase the protein content, essential amino acids, protein quality, and other nutritions content (Agosin *et al*., 1989; Anonymous, 2018; Limando *et al*., 2014). In addition, during the process of making tempe there is a decrease in the content of antitrypsin, phytic acid, and oligosaccharides which cause flatulence. The soaking, boiling, and steaming stages can reduce the activity of antitrypsin (trypsin inhibitors) (Shurtleff and Aoyagi, 1979 *in* Tsaqqofa *et al*., 2010).

It was reported by Suarsana (2009) that providing of tempeh extract at a dose of 300 mg/kg body weight/day in diabetic rats was able to lower blood glucose levels by 67.36%, increase liver glycogen levels by 2.2%, muscle glycogen by 4.02%, able to maintain the activity of antioxidant and intracellular enzymes, and can inhibit the rate of damage to beta cells of pancreatic tissue. This is because tempeh contains isoflvone bioactive compounds which have been scientifically proven to have antioxidant capabilities and hypoglycemic activity. Harnani (2009) also reported that the flour of lablab bean tempeh had higher antioxidant activity than that of lablab bean seeds. This is because the fermentation process in the lablab bean seeds can increase the antioxidant capacity of the lablab bean. The above facts are confirmed by the research results of Wardani *et al*., (2015) that the ethanol extract of lablab bean tempeh has antihyperglycemic and antihypercholesterol properties.

According to Yee (2019), good tempeh-making practices need to follow minimum requirements. This is to ensure that the resulting tempeh is of high quality. Good tempeh manufacturing practices require that the final product (tempeh) is free from contaminants and has consistent quality. It was further explained that generally good tempeh manufacturing practices refer to Good Manufacturing Practices for Processed Foods (GMP-PF/Good Manufacturing Practices for Processed Foods). To achieve good and hygienic quality, tempeh maker (small-scale industry) need to understand the predetermined tempeh quality requirements, i.e. SNI: 3144: 2015 (presented in Appendix 1).

In general, several things need to be considered in making tempeh (Yee, 2019) are: (a) location and environment, (b) buildings and facilities, (c) production equipment, (d) water supply, (e) facilities and activities for hygiene and sanitation, (f) employee health and hygiene, (g) maintenance and hygiene and sanitation programs, (h) storage, (i) determination of material specifications, and (j) product/food labeling. According to Budiharti *et al*. (Without year), the minimum requirements in the process of making tempeh hygienically are : (a) the raw material for tempe must be in good condition and not dirty, (b) the water used must be clear, odorless and not contain disease germs , (c) the yeast of tempe used must be selected which are still active (when squeezed they don't clump), and (d) the tools and method of processing must be hygienic. According to Astawan (2021), hygienic final products of tempeh are very important to support efforts to maintain consumer health, including tempeh for export.

The process of making tempeh involves three supporting factors (Harnowo and Antarlina, 2022) namely the raw materials used, microorganisms (tempeh yeast), and environmental conditions (temperature, pH, and humidity). Because the process for making local legumes tempeh is basically the same with the process for making soybean tempeh, thus in the process of making lablab bean tempeh the substrate used is mature boiled lablab bean grains. The microorganisms used are fungus, including *Rhizopus oligosporus*, *Rhizopus oryzae*, and *Rhizopus stolonifer* (which may consist of a combination of two or all three species). The supporting environment consists of temperature 30˚C, initial pH 6.8, and relative humidity 70-80%. Through this fermentation process, the elements/compounds in the tempeh seeds can be utilized more optimally by the human body during certain metabolic processes compared to when consumed in an unfermented form. Due to the services of tempeh yeast through the fermentation process, 'tempeh' has become a worldwide 'super food'. By utilizing the lablab bean as tempeh ("lablab bean tempeh"), it is hoped that it will be able to increase the added value of the lablab bean, as well as make "lablab bean tempeh" also go global and become one of the world's "super food" as well.

To date, the community have not utilized lablab beans as raw material for tempeh, at least for the last ten years (Ginting *et al*., 2002). In other words, the use of lablab beans as a food ingredient, especially as a raw material for tempeh, is still limited. A massive socialization/dissemination regarding the processing of lablab beans for various food products by using various methods, both by government and non-government is needed. This because lablab bean tempeh is considered very important for the community as a source of vegetable protein, especially when the raw material for making soybean tempeh (soybean grains) in recent years were shortage. The steps for making lablab bean tempeh are basically the same with those for making soybean tempeh, with a few modifications. Adopting the principles of making soybean tempeh (BSN, 2012 *in* Sari and Mardhiyyah, 2020), the steps for making lablab bean tempeh are :

1. Washing and soaking. This process is carried out for about 24 hours. After soaking, the seed coat is removed, then the floating seed coat is discarded, preferably with running water.

2. Boiling. Seeds that have lost their skin and clean are boiled until tender (for 0.5 – 1.0 hours), then the cooking water is removed until the remaining seed coat is discarded.
3. Cooling/draining. Slicing is done not with the seeds piled up, but spread out so that the slicing process can be evenly distributed.
4. Adding yeast/inoculation. Tempeh yeast is added on the surface of the cold lablab bean seeds (after draining), stirred thoroughly (amount of yeast 1-2 g per kg of lablab beans).
5. Fermentation. Seeds that have been spiked with yeast are evenly packed (put in containers, for example: plastic, banana stems, teak leaves, etc.) with the amount according to how much it is needed. For plastic packaging, the tip of the plastic needs to be sealed (for example using a candle flame), but prick the top and bottom of the plastic. Specifically regarding packaging, Nurmadhani et al. (2017) reported that the various types of packaging did not affect the yield of tempeh. The duration of the fermentation process is about 36 hours.

Even for soybean tempeh, there are also variations in the manufacturing process by the craftsmens. The same thing can happen to the making of lablab bean tempeh. Limando *et al*. (2014) suggests soaking (12 -15 hours) after the first boiling to produce an acidic condition. Soaking is intended to prevent the growth of spoilage bacteria during fermentation. In this way the peeling of the seed coat is done after boiling. After the seeds are separated from the skin and clean, then do the second boiling, or 'steaming' until the pieces of the seeds are cooked. Steaming aims to kill harmful bacteria. Rahayu *et al*. (2015) also explained in detail the variations in the process of making soybean tempeh.

According to Utomo *et al*. (1995 *in* Ginting *et al*., 2002), the procedures of making lablab bean tempeh are : the seeds of the lablab bean are sorted and then peeled mechanically and then washed. Next, the seeds of the lablab bean without skin were first boiled for 20 minutes, followed by soaking for 24 hours, then boiled II for 25 minutes, then drained/cooled for 4 hours. The next process is inoculation with soybean tempeh yeast and packaging, then allowed to ferment for 48 hours. Several variations may occur, usually found in the soaking time of the seeds and the boiling time, as the variations that occur in the process of making soybean tempeh (Rahayu *et al*., 2015). Cahyani and Mardiatik (2012) reported that the skin of the lablab bean was removed after the first boiling. Schematic of the process of making lablab bean tempeh is presented in Figure 7.

Fahriani (2019) has conducted research on several packaging materials related to orgaoleptic properties (taste, color, aroma, and texture) of lablab bean tempeh. In general (acceptance of consumers as a whole), the lablab bean tempeh wrapped in ‘waru’ leaf and ‘ketapang’ leaf is quite accepted by consumers. Furthermore, an analysis of the protein content of the tempeh showed that the highest protein content was in tempeh wrapped with ‘waru' leaf (18.58% or 18.58

g/100 g of material), whereas with ‘ketapang’ leaf it was 18.38%, and with ‘bananas’ leaf was 15.38%. Unfortunately, there is no specific discussion about why the differ packagings causes differences in the protein content of lablab bean tempeh. An example of the physualization of lablab bean tempeh is presented in Figure 8.

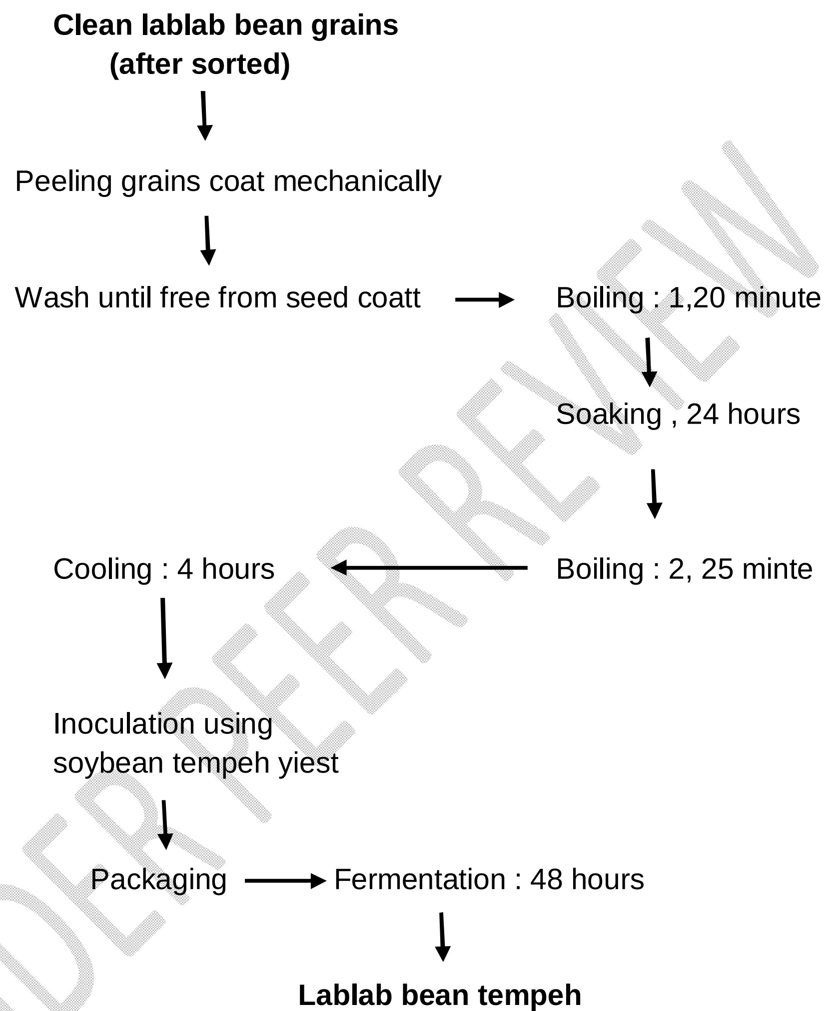


Figure 7. Schematic process in making lablab bean tempeh.
Source : Utomo *et al*. (1995 *in* Ginting *et al*., 2002).

Based on several sources, Ginting *et al*., (2002) explained that, as in soybean tempeh, the content of vitamins B such as riboflavin, biotin, niacin, folic acid and vitamin B12 increased quite high. The increase in vitamins B occurred due to the activity of the fungus R. *oligosporus* which is capable of synthesizing these vitamins. Especially for vitamin B12 produced by *Klebsiella pneumoniae* bacteria which is active during seed soaking and fermentation. The benefits of several vitamins (including in lablab tempeh) due to fermentation are briefly presented in Table 9.

Figure 8. Example of fisualization of lablab bean tempeh.
Source: Fahriani (2019).

Table 9. The benefit of several vitamins (including vitamins in lablab tempeh) for body health.

Vitamin	Benefit for the body
Vitamin A (retinol)	Allows the eye to see clearly in dim conditions, nourishes the lining of certain organs and body parts, and strengthens the immune system.
Vitamin D (kalsiferol)	Maintain blood levels of phosphorus and calcium to maintain healthy bones and teeth. Vitamin D deficiency can cause rickets in children and osteomalacia in adults. Osteomalacia is a condition where bones cannot harden, so they are prone to bending or even breaking.
Vitamin E (alfa tokoferol)	Including types of antioxidants, which function to protect body cells from damage caused by free radicals, also strengthen the immune system, maintain skin health, and protect vitamin A from certain molecules that can damage it.
Vitamin K	To activate protein and calcium which are important in the blood clotting process, and are known to have the potential to maintain healthy bones and prevent hip fractures.
Vitamin B kompleks	Affects physical and psychological health, brain function, changes in energy in the body's cells to the body's resistance to disease.
Thiamin (vitamin B1)	Helps convert food into energy and maintains healthy hair, skin, muscles, brain and nerve cells.
Riboflavin Vitamin B2	Works with other vitamins B to form red blood cells and performs the same function as vitamin B1.
Niasin (vitamin B3)	Helps the digestive process, maintaining healthy skin and nerves, converting food into energy..

Vitamin	Benefit for the body
Pantotenat acid (vitamin B5)	Helps form energy, fat, brain chemicals, steroid hormones, and hemoglobin.
Piridoksin (vitamin B6)	Helps regulate mood and sleep cycles, maintain brain function, and increase immunity.
Biotin (vitamin B7)	Helps form energy and glucose, decomposes fatty acids, and maintains healthy bones and hair.
Kobalamin (vitamin B12)	Protects nerve cells and helps form new cells, blood cells and DNA.
Vitamin C (ascorbat acid)	As an antioxidant, it maintains the health of blood vessels and bones, helps wound healing, and increases collagen production.

Source : Summary from Deswika (2021).

Beside tempeh, other processed food products that can be made from lablab beans are tofu. Tofu is a traditional processed food which so far is also made from soybeans, is the second favorite food source of vegetable protein for the community after tempeh. Tofu is made through the process of clumping protein. It turns out that it can also be used as a substitute for tofu. Research on making tofu from lablab beans has been carried out for a long time. However, in practice it is very rare or even none of the tofu craftsmen use lablab beans to reduce the amount of soybeans in making tofu. Utomo *et al*., (1992) stated that lablab beans can be used to make tofu, as a substitute for soybeans. The research by Ratnaningtyas (2003) showed that a mixture of up to 20% of lablab bean to soybean (lablab bean:soybean = 20:80) produces tofu with quite good quality, which is capable of producing protein clumps with the same texture and structure as tofu made from soybeans. Based on the results of the organoleptic test, the panelists as a whole prefered the tofu substituted with the lablab beans, although they did not like the unpleasant taste of the tofu mixed with the soybean and lablab beans. Thus, further studies for the perfection of processed food products from various local legumes (including the lablab bean) need to be continuously carried out until these food products are truly acceptable by the community, including in relation to the calculation between costs and benefits. This is relevant with the statement of Chaniago (2022) that tofu can not only be made from soybeans, but also can be made from various other legumes, including the lablab bean. Other processed food products made from lablab bean which are generally also used as side dishes are nuggets. Nuggets are a form of processed meat product that is seasoned, then covered with flour adhesive (batter), coated with bread flour (breading), and half-cooked then frozen to maintain its quality after storage (Tanoto *in* Girindra, 2016; Damayanti, 2021). Nuggets are a type of fast food, which are generally made from various animal ingredients such as chicken

(chicken nuggets), shrimp (shrimp nuggets), or can also be made from vegetable materials such as tofu (tofu nuggets), and spices. Serving the nuggets is done by first coating the nuggets with egg white and flour, then frying (Cahyani and Mardiatik, 2012).

In the practice of making lablab bean nuggets, Cahyani and Mardiatik (2012) made a mixture with 67% lablab bean tempeh and 33% chicken meat. To reduce the unpleasant smell of the tempeh, the tempeh is steamed before it is processed into nuggets. Seasonings are also added to get the flavor of the nuggets so that consumers like them and to increase the nutritional value of the resulting nuggets. In summary, the result is a nugget is almost the same shape as the chicken nuggets on the market. The steaming of the tempeh can reduce the unpleasant smell caused by the tempeh of the lablab beans. The appearance of the lablab bean nuggets is presented in Figure 9. The result is that the lablab bean nuggets are equivalent to chicken nuggets according to SNI 01-6682-2002 (Table 10). Complete requirements for the quality of chicken nuggets according to SNI 01-6683-2002 are presented in Appendix 2.

Figure 9. Nuggets made from lablab beans.
Souce : Cahyani dan Mardiyatik (2012).

Table 10. Chemical composition (nutrition) of lablab bean nuggets as compared to chicken nuggets SNI.

Nutrition component	Lablab nuggets*)	Chicken nuggetsaccording to SNI 01-6683-2002
Water (%w/w)	45,85	Max. 60
Aah (%)	2,26	-
Protein (%)	11,87	Min. 12
Fat (%)	9,91	Max. 20
Crude fiber (%)	2,48	-
Carbohydrate (%)	28,38	Max. 25
Energy (kkal)	249,70	-

Antioksidant	17,85	-
HCN	3,48	-

Remark : *)analysis result.
Source : Cahyani dan Mardiatik (2012)

Organoleptic test result on the lablab bean nuggets showed that in terms of texture, appearance, and preference, the lablab bean nuggets were similar with chicken nuggets. Meanwhile, in terms of taste, the lablab bean nuggets did not differ with chicken nuggets from the market. It was concluded that the lablab bean nuggets produced from this research were acceptable to consumers so it was very possible to produce them.

Other processed food products that are very popular as side dishes for along time are sausages. Sausage is a processed food made from meat served as protein food source. Sausages can also be referred to as one of the processed meat products, with a distinctive shape, which is round, elongated, sleeved, and has a chewy texture. Therefore, in the formation of sausages, cashing or sleeves are needed which function as containers for meat emulsion which determine the shape and size of the product, as well as attracting consumer attention. Meat-based sausages are generally high in cholesterol and low in fiber. One of the efforts to produce sausages that are low in cholesterol and high in fiber and has a high protein content is to switch from meat to vegetable protein-based sources. Various local legumes, with their nutritional quality, are considered to meet the requirements to be used as substitutes or even replace them entirely for making sausages (Tsaqqofa *et al*., 2010). An example of visualization in general of sausages is presented in Figure 10.

Figure 10. Example of visualization of sausages made from lablab bean.
Source : google.com/Search?sxsrf=AJOqlzUjL_.....

Utilization of various legumes (including lablab beans) to make sausages must first to be made tempeh. This is to overcome the weakness of legume bean seeds flour which generally has an unpleasant aroma, and the content of anti-nutritional compounds is still high. Making tempeh will remove the unpleasant aroma and reduce levels of anti-nutritional substances, as well as make the nutrients in the seeds more absorbable/usable by the body. Therefore, there are four stages in the process of making sausages from various legumes (including lablab beans), namely: (a) making tempeh, (b) making tempeh flour, (c) making TVP or *Texturized Vegetable Protein*, and (d)) sausage making. The preparation of the lablab bean tempeh has been explained IN previous sub-chapter. Schemes for making tempeh flour, making TVP and making sausages are presented in Figures 11, 12 and 13.

Cutting fresh tempe using slicer

↓

Drying for 4-6 hours using Oven dryer, temperature 70-80^{O}C

↓

Milling

↓

Shifting tempeh flour using 60 mesh siever

↓

Tempeh four

Figure 11. Flow diagram in making tempeh flour.
Source : Tsaqqofa *et al*. (2010).

Tempeh is a fermented product that cannot preserve long time. After 2 days, tempeh will decompose so that it becomes less suitable for human consumption. One way to extend the shelf life of tempeh is to process it into tempeh flour. The benefits of making this flour include being easily mixed with other flours to increase its nutritional value and easy to store and make into nuggets and sausages (Tsaqqofa *et al*., 2010). The fermentation process in tempeh causes the components in the seeds (tempeh ingredients) to be hydrolyzed so that they become simpler and easier to digest. In general, processing legumes seeds into tempeh will increase the protein content, essential amino acids, protein quality, and other nutritional substances. In addition, during the process of making tempeh there is a decrease in the content of antitrypsin, phytic acid, and oligosaccharides which cause flatulence. Soaking, boiling and steaming can reduce antitrypsin activity (Ginting *et al*., 2002).

The high protein but low fat nature of the lablab bean flour makes it possible to use it as a protein-based food such as TVP which does not require the fat extraction process first so it is easier to make and does not require time longer. Thus, the manufacture of PRF from lablab been flour can replace *Texturized Soy Protein* (TSP), which is currently a mainstay in the manufacture of artificial meat products which will then be applied to the manufacture of food products in the form of sausages (Tsaqqofa *et al*., 2010). Thus, TVP can be defined as a type of artificial processed meat product that has a function resemblance to meat in several characters such as texture, flavour, and color. TVP can be classified as a protein engineered food product that is made to get better benefits than real meat. *Texturized Vegetable Protein* (TVP) of lablab bean can be used as an alternative to *Texturized Soy Protein* (TSP), which in turn can be applied to the manufacture of lablab bean sausage products. Bassically, not only from lablab bean flour or lablab bean tempeh flour, the TVP can also be made from lablab bean sprouts. Based on the research results of Rahmawati (2013), lablab bean sprouts can be made into flour first before it be used as a substitute for beef. Furthermore, such materials can be made into various food products such as sausages, nuggets, and meatballs. Widiastuti and Judiono (2017) also reported that lablab bean extract can be used to improve the quality of yoghurt

Lablab bean tempeh

↓

Mixing gluten and
Lablab bean flour

↓

Adding other ingredients
(vegetble oil, flavour agent, CaCl2, water)

↓

Extruction with variation in temperature

↓

Catch and dry with oven dryer (50 OC)
until moisture content < 10%

↓

Texturized Vegetable Protein
(TVP) of lablab bean

Figure 12. Flow diagram in making TVP of lablab bean.
Source : Tsaqqofa *et al*. (2010).

Milling of formulated TVP

↓

Add tapioca, powdered sugar, and seasonings
(15 : 3 : 1), MSG, tripolyphosphate salt, fright oil,
and egg white

↓

Dough rolling

↓

Inserted into *stuffer*

↓

Boiling, temperature 80 ^{O}C, 15 minutes

↓

Cooling

↓

Lablab bean sausages

Figure 13. Flow diagram of producing lablab bean sausages
Source : Tsaqqofa *et al*. (2010).

Apart from being used for the manufacture of several types of foods, lablab beans can also be added to fresh milk in making yoghurt(Safrida, 2019; Wardani and Pahriyani, 2018). The results of Safrida's research (2019) show that the addition of lablab bean flour can improve the quality of the yoghurt produced, especially in terms of its protein content and meet the requirements, even the protein content is higher than the protein quality standards according to SNI 2981-2009.

d. Lablab bean as medicine.

According to people's habits in several countries (based on folklore) from various sources compiled by Stuart Jr. (2019), the lablab bean crop is used as a traditional medicine (to reduce or cure various diseases). The benefits of the lablab bean as a traditional medicine are presented in Table 11.

Table 11. The utilization of lablab bean crop as medicine in several countries.

Country	Plant part and potion	The benefit as medicine
Malaysia	Leaves mixed with rice flowers and tumeric are blendered.	For eczema poultices
Indo-China	1. The boiled water of leaves is drinked 2. The boiled water of flowrs 3. The boiled water of seed	1. As medicine for colic 2. For drugs for excessive menstrual pain and leucorrhoea 3. To stimulate lust and leu-corrhoea medicine
China	1. The boiled water of mature/ripe of seed 2. Seed	1. For refreshing drinks and make it easier to release gases. 2. For febrifuge, stomach ache medicine, and anti-spasmodic.
Bangladesh	1. Pounded/ crushed leaves 2. Leaf paste 3. Mature seeds are drunk/eaten	1. For poultices around the throat as a reliever for tonsil inflamation 2. To treat skin diseases 3. To increase the sperm count
India	1. Mature seed paste 2. Leaves juice mixed with milk	1. To treat scorpion stings 2. To treat arthritis
Nepal	Leaf and seed juice	To relieve/reduce stomach pain
Philippine**)	1. Young seeds are boiled/steamed, added with chilies or curry 2. Mature seeds are boiled	1. As tradicional herb medicine to reduce body temperature 2. To easier to remove air and reduce body temperature

Source : Stuart Jr. (2019).
*)Anonim (2010); **)Hartoyo (2008) and Nafi' *et al*. (2013).

Beside as traditional medicine as presented in Table 11, based on several research results (Harnani, 2009; Suarsana, 2009; Subagio and Morita, 2008; Hartoyo *et al*., 2011; Nafi' *et al*., 2013; Wardani and Pahriani, 2018; Yin *et al*., 2018) lablab beans can also be used as a medicine to lower cholesterol, blood glucose levels and LDL cholesterol, and also can be used as weight loss/anti-obesity. An *et* *al*. (2020) also found that preemptive intake of extracts of lablab bean significantly rescued gastric stress-related mucosal disease (SRMD). These facts reaffirm the benefits of lablab beans for human health. With their health benefits, it shows that the development of the lablab bean is very prospective in the future, especially in the context of food and industrial development.

3.4. The benefit of tempehnutrition for health

This sub-chapter is deliberately raised considering that tempeh is a processed food product inherited from the ancestors of the Indonesian nation. In addition, until now tempeh is a source of vegetable protein that remains affordable for most people. In fact, not only for most people, especially in Indonesia, tempeh has now become a "global" specialty food. Therefore, the nutritional benefits of tempeh (including tempeh made from lablab bean) for the health of the body need to be understood by the public so that there is no doubt for consumers/public to consume non-soy tempeh.

The nutritional benefits of non-soy tempeh of other legumes (including lablab bean) are similar to those of soy tempeh because the nutrient content in the seeds of various other legumes is also equivalent to that in soybean seeds. The content of nutrients that are quite complete so it is very beneficial for the health of the body. Link (2019) in his article wrote about the seven main health benefits of tempeh. In general, a certain amount of soybean tempeh contains carbohydrates, protein, fat, and the elements Mn (manganese), Cu (copper), P (phosphorus), Mg (magnesium), Fe (iron), Ca (calcium), K (potassium), Zn (zinc), and other compounds such as folate, thiamin, riboflavin, and phantothenic acid. Furthermore, referring to several research results (sources not written in this book) explained that in general the seven main benefits of tempeh are: (a) as a nutrient-rich food, (b) very useful for regulating/maintaining weight, (c) able to supports heart health, (d) an important source of antioxidants, (e) able to improve intestinal health (digestive tract), (f) can help fight against cancer cells, and (g) proven to be rich in bone-forming nutrients, such as the elements phosphorus (P), Calcium (Ca), Magnesium (Mg), and Cooper (Cu),

Aryanta (2020) has also summarized various literatures regarding seven medical benefits of tempeh in general, beside those that have been mentioned early, namely : (a) can lose weight, (b) prevent anemia, (c) prevent asthma, (d) reduce the risk of Parkinson's, especially Niacin content in tempeh, (e) meets the needs of vitamin B12, and (f) improves brain performance. A more complete explanation of the benefits of consuming tempeh can be seen in a previously published book (Harnowo and Antarlina, 2022).

It is important to be emphasized again that fermentation is a very vital and amazing process in making tempeh. The existence of this fermentation process in soybean seeds and in the seeds of various local legumes causes changes in functional properties as a result of hydrolysis processes which include hydrolysis of proteins into amino acids and peptides by proteolytic enzymes and hydrolysis of oligosaccharides into monosaccharides, as well as degradation of phytic acid into organic phosphates (Ribotta *et al*., 2010). Fermentation also makes changes in terms of vitamin content. According to Astuti *et al*. (2000 *in* Dewi *et al*., 2014), that during tempeh fermentation the amount of vitamin B complex increased except for thiamin (vitamin B1). Vitamin B12 is produced by the bacterium *Klebsiella pneumoniae* which is a desired microorganism in the natural tempeh fermentation process. The presence of these bacteria in tempeh is due to the carbohydrate content which is a substrate for K *pneumoniae* which synthesizes sucrose in carbohydrates as a food source.

According to Roubas-van den Hill *et al*. (2010 *in* Sari and Mardhiyyah, 2020), the Rhizopus mold present in tempeh can produce antibiotics that are capable of fighting several disease-causing microbes. These antibiotic compounds are also useful for inhibiting and reducing inflammation. Mawaddah *et al*. (2018) also reported that the ethyl acetate extract of tempeh with concentrations of 25%, 50%, and 75% had an inhibitory effect on the development of *Staphylococcus aureus* bacteria by 6.6 mm, 6.7 mm, and 7.5 mm, respectively. compared to the positive control using amoxicillin, which is 31.8 mm. The antibacterial activity produced from tempeh is included in the moderate category.

To close this chapter, it is important to note the statement of Sari and Mardhiyyah (2020) that protein from non-soybean tempeh (including protein from lablab bean tempeh) has great potential as a source of protein (mainly vegetable protein) for the community, especially in conditions where domestic soybeans are experiencing disruption to the supply of raw materials for soybean tempeh. It was further stated that the protein contained in non-soybean tempeh has many benefits, such as producing umami taste, preventing diarrhea, and as a source of protein isolate.

CHAPTER 4. CULTIVATION TECHNIQUE FOR LABLAB BEAN

Before explaining in more detail the cultivation techniques, it is necessary to convey the conditions for growing the lablab bean crop and the agroecological conditions in which the lablab bean is widely cultivated. This is important as the basis for the development of lablab beans, especially those related to the location of the development and the cultivation techniques to be applied. Lablab beans can basically grow, both in tropical and subtropical regions. The air temperature for the best growth is 18-30 ^{O}C. However, this crop can still grow and produce well at temperatures around 35 ^{O}C. This crop is known to be very tolerant of drought and can adapt well to dry land or even to marginal land with rainfall of 200-2500 mm/year (Duke, 1983). Lablab bean crop also have high adaptability with low to high production inputs such as fertilizer and water (Adebisi and Bosch (2004 *in* Azkiyah, 2017). As a type of legume crop, this crop has the ability to conserve and improve soil fertility and soil cover, as well as its forage is very good for animal feed (Ispandi and Munib, 2002; Murphy and Colussi, 1999; Trustinah and Kasno, 2002). In Indonesia, lablab bean crops are generally cultivated in areas with the agroecology of dry land with dry climates (Utomo *et al*., 1992; Joko, 2010; Pamungkas, TanpaTahun).

4.1. The provision of high quality seeds.

The availability of seed with the "six right" requirements (right variety, right amount, right quality, right time, right location, and right price) is an important prerequisite, even the second important prerequisite after water for the success of lablab bean cultivation. Related to the above aspect, however, until now Indonesia does not have varieties that have been officially released by the government. This has caused the seed industry activities from upstream (procurement of Nucleus Seeds and Breeder Seeds) to downstream (procurement of Extension Seeds) in the context of supplying quality lablab bean seeds in sufficient quantities to meet the needs cannot be carried out. Both directly and indirectly, this is the impact of the not positioning of the lablab bean as an important food crop commodity such as for example rice, corn and soybeans. As a result, in supplying seeds of the lablab bean, so far farmers have provided their own seeds from the previous season's crop yields, and the yield from the present season's crops that are stored for the next (upcoming) season. Or, farmers usually purchased seeds from another farmers or grain traders (which is actually not certified seeds), or, from other places. Such method of providing seeds as explained above is called a self-seed supply system (‘saved seed’) (Manzalina *et al*., 2013), as occured in the provision of soybean seeds by around 65% of farmers in Indonesia (Harnowo, 2017).

The above situation is in line with the results of a survey in Probolinggo, East Java (Azkiyah, 2017) which showed that the majority (around 85%) of lablab bean farmers used grains (actually not seed) as seed. The majority of farmers provide seeds by saving a portion of the lablab bean pods they harvest. Lablab bean pods are dried naturally until the skin of the pods is brownish and the grains are separated from the pod shells, sorted and stored as planting material for the next (upcoming) growing season. Several other farmers buy planting material (grains) for seeds (grains which is believed suitable for planting) at the nearest market, for example at the Nguling, Tongas, Lumbang, Muneng, Patalan, Bantaran and Leces markets. Making seeds (planting material) by farmers is very possible (Harnowo, 2019) because legume crops (including lablab bean) are generally self-pollinated so there is very little dought about cross-pollination and therefore the level of seed purity remains relatively unchanged. Lablab bean seeds belong to the group of 'orthodox' seeds.

The group of 'orthodox' seeds is characterized by the need for low water content after the seeds reach physiological maturity/optimum ripening. Thus, water in the seeds need to be removed immediately, or, seeds need to be dried immediately to a safe moisture content to maintain the high germination during storage. In this way, the physiological quality of the seeds can still be guaranteed after storage or when they are replanted in the following season. The seeds needed for planting of lablab bean range from 90 – 125 kg/ha.

4.2. Soil preparation, fertlization, planting distance, irrigation, and weeding.

Land preparation is intended to loosen the soil and clear the land of weeds before planting begins. Because lablab beans in Indonesia are generally planted on dry land, where the planting period is at the beginning of the rainy season, soil preparation needs to be done, even farmers prepare the land 2-3 weeks before planting. In addition, Pamungkas (TanpaTahun) reported that in Indonesia, lablab beans are generally grown not in intensive monoculture, but in intercropping with the main crop. An example of planting lablab beans on dry land (with an intercropping system) after the main crop (maize) has been harvested is presented in Figure 14.

Figure 14. Example of lablab bean crop on upland area in a multiple cropping system after the main crop (mayze) were harvested.
Source : Indriawati (2019).

Based on several research results, Murphy and Colucci, (1999) stated that the lablab bean can be planted in various types of soil, ranging from deep sandy soil to loamy black heavy soil and is tolerant to a pH of 5 – 7.5. This crop can survive shortly in flooded conditions so that it can grow well on alluvial soils. In this regard, proper drainage (usually 20-30 cm deep) is required. In relation to fertlization, so far the results of recent studies regarding optimal fertilization doses for lablab beans were difficult to obtain. This shows that until now the recommendations regarding fertilization for intensive farming of this crop have not yet been made. However, Listiana and Sumarjan (2008) reported in their research that: (a) irrigation only once at planting, b) fertilization with 50 kg Urea/ha + 100 kg/ha SP36, 100 kg KCl/ha, c) plant spacing 50 x 50 cm, and d) weeding at 2 and 4 WAP. The application of the above technological package of technology was considered sufficient for providing ideal growth of lablab bean.

Utomo (1991) reported that : (a) by only land preparation and weeding, the dry seed yield of 0.40 t/ha was obtained, (b) when soil preparation was combined with weeding and pests and diseases control, the dry seed yield obtained was 0.64 t/ha, and when the treatmet point b) was applied with 40 kg of Urea + 90 kg of TSP + 90 kg of KCl per hectare, the dry seeds yield obtained was 0.74 t/ha. Regarding the plant population per hectare, Supriyatin *et al*. (1993 *in* Ahmad, Without Year) reported that with a population of 125,000 plants/ha (plant spacing 40 cm x 20 cm, 1 seed/hole) in monoculture system, the seed yield was 1.17 t/ha, whereas in intercropping the seed yied was 0.91 t/ha, while by intercropping the seed yield was 0.91 t/ha. If the population is increased to 250,000 plants/ha (plant spacing 40 cm x 20 cm, 2 seeds/hole), in the monoculture system the seed yield obtained was 1.00 t/ha, whereas in intercropping the seed yield was 0.70 t/ha. The research results of Oktian (2020) showed that plant spacing of 40 cm x 20 cm is the best and therefore can be recommended for the cultivation of lablab beans.

Because lablab beans are mostly grown in intercropping, below is a suggestion regarding the cultivation of lablab beans using an intercropping system with mayze as the main crop (Figure 15). Variations in the intercropping system can be carried out, for example between two rows of corn is filled with 2 rows of lablab crops, by widening the distance between the two rows of mayze crops. Or, make double rows of mayze crops (with a distance of about 40 cm) and 1 row of lablab bean crops. To minimize shading effect of the mayze crops, the lablab beans can be planted 7-10 days before planting the mayze, when the soil moisture is sufficient for the germination of the lablab bean seeds.

On dry land or on upland, mayze is planted at the beginning of rainy season, by first cultivating the land, either as a whole or only on the land planned for mayze crop rows. The risk if tillage is done only for rows of mayze crops is the rapid growth of weeds between the rows. By intercropping mayze with lablab beans, it is strongly recommended that the soil need to be tilled as a whole before planting (1-2 weeks before planting). And, it would be better if organic manure (livestock manure) was applied simultaneously with the tillage (soil preparation) so that the organic manure would be distributed evenly on the tilled layer at the same time with the land preparation. According to Oktian (2020), 5-10 t/ha of chicken manure is needed for the cultivation of lablab beans.

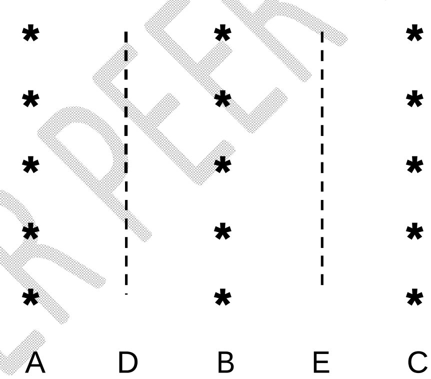


Figure 15. One of example of lablab bean cultivation alternative (intercropping system with mayze).

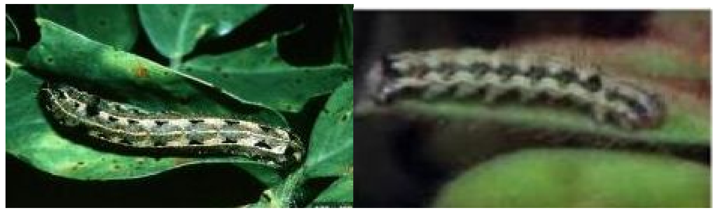
Remark : A, B, and C = rows of mayze crops, distance of mayze hole in the row is arround 30 cm; distance A – B or B – C is arround 75 cm; D and E = row of lablab bean; distance between holes in rows of lablab bean is arround 20 cm.

4.3. Pests and diseases control.

Based on several literatures, Murphy and Colussi (1999) reported that although there are several pests and diseases may attack lablab bean crops, only a few can cause serious damage that crop. In fact, in several countries where the lablab bean is widely cultivated, this crop is relatively free from pests and diseases. In Honduras, for example, they reported that *Diabrotica* spp. was found attack the crop. However, the extent of the attack and the negative impact or loss from the resulting attack was not significant.In Indonesia, very rare report regarding pests and diseses that attack lablab bean in the field. There was report that armyworm and pod suckers attacking the crop but the economic impact was not significant. An example of lablab beans crop without serious pest attacks is presented in Figure 16.

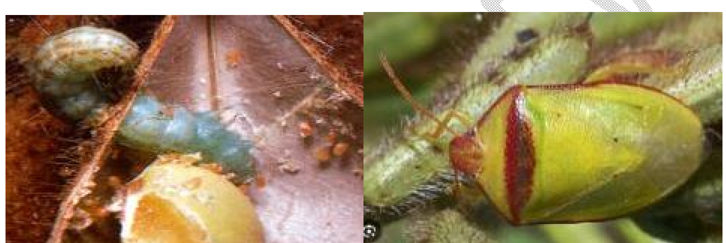
Figure 16. Lablab bean crops in dry land area without significant pests and diseases attack.
Source : tanidata.com/2022/01/29/petani-untung-..

Based on those information, the control activities in the field as well as research on the aspect of pest and diseases control on lablab bean are also very rarely conducted. However, considering that the lablab bean is also a host for important pests for various legumes crops, thus several important pests for legumes in Indonesia have the potential to attack the lablab bean crops.Thus, important pests such as *Spodoptera* sp., *Heliothis armigera*, *Riptortus linearis* and others (Figure 17) needs to be watched out.



Spodoptera litura *Heliothis armigera* Hubner

Riptortus linearisOphiomya phaseoli



Etiella zinckenella Treit *Piezodorus hypneri* Fabricius

Figure 17. Several important pests on legumes, especially on soybean. Source : Marwoto *et al*. (2017).

4.4. Harvest and post harvest handling.

Harvesting of the lablab beans both for grains and especially for "seeds" need to be done when the pods have shown the color of ripe pods, which are white or brown. In this stage the dry weight of the seeds has reached maximum. Harvesting can be done by picking the pods from the plants in the field, or by cutting the stems of the plants at the base (3 - 5 cm above the ground). Harvesting by cutting plant stems can be done if it is assessed that a second or third harvest is not needed. The old pods that have been harvested and collected need to be dried immediately so that the seeds dry quickly for further separation of the seeds from the pod shells. The dried pods can be put in guni sacks or plastic sacks and then beaten (not too hard) with wood. Stork in the form of leaves and pod shells should be returned to the land as organic matter which will improve the structure and fertility of the soil.

The seeds that have been separated from the pod shells are then cleaned until they are free of dirt, then stored in sacks or aluminum containers. For "seed" purposes, the clean and collected seeds need to be selected for uniform size, uniform skin color, and no physical defects for further storage under conditions with fairly low moisture content (around 10-12%) by using airtight and moisture-tight storage containers. This is to keep constant its moisture content during storage.

CHAPTER 5. PROSPECT FOR THE DEVELOPMENT OF LABLAB BEANIN INDONESIA

As one of the genetic resource of food crops in Indonesia, the lablab bean should be considered as a crop that has multiple functions, both in terms of actual and potential aspects. Actually these commodities can function as subsistent commodities as well as a source of cash income for farmers. Potentially, the product of this crop is a functional product with a higher added value than just for daily food for direct consumption. So, it is undeniable that the lablab bean has considerable potential to be developed. Some of these potentials can be explained from several aspects, as follows:

a. From the aspect of environmental sustainability, the lablab bean crop can function as a soil fertility enhancer and as a ground cover that can reduce land degradation due to erosion.

b. From the aspect of its use as animal feed, the forage of the lablab bean crop and the residue/waste from the production process of lablab bean-based foodstuffs are high-quality feed ingredients as an alternative for ruminants' feed.

c. From the aspect of the nutritional value of seeds for health, the lablab bean has the amount and nutritional value equivalent to those of soybeans, including its role as a functional food because of its nutritional content that resembles soybeans. This aspect strongly supports the merits of making lablab bean as at least as a substitute material in the manufacture of soybean based processed food products, for example tempeh, tofu.

d. From the market (demand) aspect, the seed yield of lablab bean is quite attractive to the public, although until now it seems that it is used more for vegetables (both in the form of young pods and seeds). This is proven that these commodities are exist/sold in the market, although they are still carried out by trades individually (uncoordinated).

e. From the aspect of its function for the substitution of imported commodities, lablab bean is a commodity capable of substituting imported goods/commodities, especially soybeans because of its excellent potential and is suitable as an ingredient for the manufacture of processed food (especially tempeh, which is until now has been made from soybeans).

f. From the aspect of potential area for development, basically there is still a lot of land/area that can be used to produce lablab beans, including during the dry season 2 (DS II) on lowland after rice crops where it is no longer possible to plant mayze, soybeans or peanuts. Beside that, “The Perhutani lands” with young main crops (<15 years old), and also lablab bean is also very prospective to be developed on suboptimal lands.

g. From the aspect of the utilization of local resource-based food ingredients (following The Law No. 18/2012 concerning Food, it is explicitely stated that the Government of Indonesia strongly stipulates the use of local resource-based food ingredients (of course including lablab beans), especially those that have not been utilized optimally, especially as raw material for tempeh.

In the context of developing the lablab bean in Indonesia, there are still several obstacles, including: (a) the commodity of the lablab bean has not yet been considered as an important food crop commodity such as rice, corn and soybeans, (b) to date there has been no superior variety officially released by the Government, (c) the trade system for the lablab bean commodity has not been well organized, and (d) there has not been massive socialization from the central to the regional level government regarding the importance of lablab bean as a highly nutritious food as well as a functional food which is very important for the body health, and (e) there is no guarantee for farmers to gain access to production facilities and infrastructure in broad way for the farming of lablab beans.However, it is believed that the prospects for the development of lablab bean in Indonesia are quite large, especially related to the provision of food sources for vegetable protein that are quite affordable for the community, moreover this commodity is very potential and even very feasible as a substitute for soybeans for tempeh. More importantly, the broad prospects for developing lablab bean must be seen from its wider role and function, namely to support regional and national food security.

To support the implementation of the development of lablab bean in Indonesia, several strategic steps that need to be taken immediately include: (a) socialization regarding the potential of lablab bean as a food ingredient, especially as a raw material for tempeh, as well as providing technology assistance for making tempeh made from lablab beans to the tempeh craftsmen or certain groups of people who are interested in becoming non-soybean tempeh producers, (b) The government needs to immediately carry out activities related to efforts to release superior varieties of lablab bean in the framework of planning and producing the seeds of the lablab beans which can fulfill the “six right” requirements sufficiently, (c) adequate planning for the production of lablab beans as a raw material for tempeh in each region, and (d) support from the central government to set the position of lablab bean commodity having the same position/importance with another strategic commodities as an important food source.

The Regional Government is considered to have a very strategic role in providing and meeting the food needs of the community in the area, as stated in the

Food Law No. 18/ 2012. One concrete example of the role of the Regional Government in encouraging and inviting its people to develop food commodities is what the Top Leader of Gunung Kidul did (Agronet, 2020) to expand pigeon pea farming in their areas. If similar things can be done in various regions, then it is believed that the development of certain food commodities, including lablab bean, will be successful. This success will have a double impact, namely increasing the consumption of various highly nutritious local legumes for the local community, opening up employment opportunities and the welfare of the community, including farmers, as well as increasing food diversification, especially for the consumption of legumes. The great prospects for the development of lablab bean are inseparable from the support that the lablab bean is one of the types of local legume as a functional food (Subagio and Morita, 2008; Kante and Reddy, 2013; Liu, 2020; Nafi' *et al*., 2006; 2013; 2014; Sari and Mardhiyyah, 2020). Equally important is the need of support from government for research on various aspects of the lablab bean. In this case, the government has encouraged the development of lablab bean because such commodity is considered quite profitable for farmers (Aquinus, 2019). In other words, every effort to reveal the potential and promote genetic resources of lablab bean as local legume as an alternative (at least as a substitute) for processed food products, especially those based on soybeans, needs to be highly appreciated.

Areas potential to develop the cultivation of lablab beans are mainly those with dry land agroecology, both wet and dry climate types, including lands in forest areas managed by the community. Upland fields (yards) as well as paddy fields with limited irrigation facilities (including lowland during dry season 2 (dry season II) are also potential for the development of this commodity.

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CHAPTER 6.CONCLUSION

Since several decades ago, dependence on imported soybeans has been increasingly felt. Moreover, domestic soybean production tends to decrease which causes the trend of soybean imports to increase. In such conditions the need for raw materials for processed food products based on soybeans originating from various local legumes as a substitute for soybeans is increasingly being felt. Indonesia is basically rich in biodiversity, including the lablab bean crop. However, the utilization of the lablab beans, especially for raw materia for tempeh, is not yet optimal.

Research on the utilization of lablab bean as raw material for tempeh has been carried out for a long time. The results showed that the lablab bean can be used as a raw material for tempeh with the same quality as soybean tempeh. Based on the organoleptic test, in general, tempeh made from lablab bean is quite prefered by respondents, or, in other words it is acceptable by consumers. Thus, the lablab bean has great potential to be used as raw material for tempeh as a substitute for soybeans. It seems that the lablab bean crop, as discussed in this book, can still be categorized as a traditional crop, both from the aspect of its cultivation and those from its utilization. The scale of farming is generally small, scattered and not in the form of well-coordinated cultivation. It seems that the existence of the lablab bean is 'location specific', or, it is only cultivated not intensively in certain areas. This indicates and has implications that the development of tempeh made from lablab bean is 'locatio specific' as well.

The fundamental problem for the development of tempeh made from non-soybeans is not whether or not raw materials other than soybeans can be made into tempeh, but rather the supply of logistics (availability of the grains of the lablab bean) in an adequate and sustainable manner, at competitive prices with soybean prices. If it is agreed that soybeans as the main raw material for tempeh will be replaced by lablab beans, then several important policies are needed, including:

(a) each region (Regency/City and Province) needs to identify whether there are lablab bean planted by farmers in that area, followed by the extent to which they are utilized by the local community,

(b) if it is proven that the farmers cultivate lablab beans, it is necessary to carry out massive dissemination and promotion in order to optimally accept and use lablab bean as raw material for 'non-soybean tempeh' by all levels of society/tempeh consumers,

(c) carry out comprehensive planning for the production of lablab beans together with farmers, including how much to produce, where and when to produce, preparation of seeds and other production facilities,

(d) preparing and strengthening Farmers' Groups for producing lablab beans, as well as preparing models/forms of the lablab bean trading system, as well as ensuring the running and development of home industries of tempeh made from lablab bean.

In connection with the matters mentioned above, all parties (*stake-holders*) related to 'non-soy tempeh', both those engaged in on farm and off farm aspects need to cooperate optimally. In this way, the supply of quality seeds of the lablab bean in large quantities can be carried out by producing lablab bean grain with certified seeds in sufficient quantities for production deve-lopment. In addition, more in-depth and comprehensive research is still needed, especially related to the technique of cultivating lablab bean which is able to generate a high income for farmers and improving the trading system so as to be able to encourage farmers' enthusiasm to develop lablab bean agribusiness optimally. And finally, based on the potential benefits and utilization of the lablab bean which is quite large, the suggestion of the lablab bean as a "crop and super food", as a substitute for soybeans, as appointed in the title of this book needs to be accommodated or considered. Finally, our discussion concering lablab bean in this book reveals that this commodity is very prospective to be developeded in Indonesia, not only as substitutes for soybean as raw material for tempeh, but also for other industrial purposes.

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APPENDIX

Appendix 1. Quality requirements of soybean tempeh according to SNI 3144 : 2015.

No.	Kind of test	Unit	Requirement
1.	Condition		
1.1.	Texture	-	compact, if sliced it stays intact (does not fall off easily)
1.2	Color	-	putih merata pada seluruh permukaan
1.3.	Smell	-	typical smell of tempeh without the smell of ammonia
2.	Moisture content	mass fraction, %	max. 65
3.	Fat content	mass fraction, %	min. 7
4.	Protein content (N x 5,71)	mass fraction, %	min. 15
5.	Crude fiber content	mass fraction, %	max. 2,5
6.	Metal contamination		
6.1.	Cd	mg/kg	max. 0,2
6.2.	Pb	mg/kg	max. 0,25
6.3.	Sn	mg/kg	max. 40
6.4.	Hg	mg/kg	max. 0,03
7.	Arsen (As)	mg/kg	max. 0,25
8.	Microbe		
8.1.	Coliform	APM/g	max. 10
8.2.	Salmonella sp.	-	negative/25 g

Source : BSN (2015).

Appendix 2. Quality requirements for *ChickenNugget* according to SNI 01-6683-2002.

No.	Kind of test	Unit	Requirement
1.	Condition		
	1.1. Scent	-	Normal
	1.2. Flavor	-	Normal
	1.3. Texture	-	Normal
2.	Foreign object	-	Not allowed (none)
3.	Water	%, w/w	Max. 50
4.	Protein (N x 6,25)	%, w/w	Min. 12
5.	Fat	%, w/w	Max. 20
6.	Carbohydrate	%, w/w	Max. 20
7.	Kalsium (Ca)	mg/100g	Max. 30
8.	Food additive		
	8.1. Preservatives	-	Following SNI 01-0222-1995
	8.2. Coloring agent	-	-
9.	Metal contamination		
	9.1. Cd	mg/kg	Max. 0,1
	9.2. Pb	mg/kg	Max. 1,0
	9.3. Sn	mg/kg	Max. 40,0
	9.4. Hg	mg/kg	Maks. 0,03
10.	Arsen (As)	mg/kg	Max. 0.5
11.	Microbe		
	11.1. Total plate number	Colony/g	Max. 5x10^{5}
	11.2. *Coliform*	APM/g	Max. 10
	11.3. *E.coli*	APM/g	< 3
	11.4. *Salmonella*	-	Negative/ 25 g
	11.5. *Staphylococcus Aureus*	Colony/g	Max. 1x10^{2}
	11.6. *Clostridium perfringens*	Colony/g	Max.1x10^{2}

Source : BSN (2014) : SNI 01-6683-2014.

Appendix 3. Quality requirement for Yoghurt according to SNI 2981- 2009.

No.	Kind of test	Unit	Requirement
1.	Condition		
	1.1. Appiarance	-	semi-solid viscous liquid Normal, typical
	1.2. Smell	-	Sour/typical
	1.3. Flavor	-	Homogen
	1.4. Concentration	-	
2.	Fat content	%	Min. 3,0
3.	Total non-fat milk solids	%,	Min. 8,2
4.	Protein	%,	Min. 2,7
5.	As content	%,	Max. 1,0
6.	Acidity (calculated as lactic acid)	%,	0,5 – 2,0
7.	Microbe contamination		
	7.1. *Coliform*	APM/g or colony/g	Max. 10
	7.2. *Salmonella*	APM/g	Negative/26 gr
	7.3. *Listeria monocytogenes*		Negative/25 gr
8.	Jumlah bakteri starter	colony/g	Min. 10^7

Source : BSN (2009) : SNI 2981-2009.

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