Rendiconti
Accademia Nazionale delle Scienze detta dei XL
Memorie di Scienze Fisiche e Naturali
133° (2015), Vol. XXXIX, Parte II, Tomo I, pp. 251-257

POPI SEPTIANI*

Family farming: the case of Indonesia

1. *Agricultural situation in Indonesia*

A population of 254 million lives makes Indonesia the world's fourth most populous country, with its population growing at a rate of 1.4% per year. The agricultural sector in Indonesia plays a strategic role in the structure of national economic development also to provide food for the nation. Agriculture accounts for 14% of

Table 1. Top ten commodities production quantities in 2012.

No	Commodity	Quantity (Tons)
1.	Rice (paddy)	69,056,126
2.	Sugarcane	28,700,000
3.	Oil Palm	26,900,000
4.	Cassava	24,177,372
5.	Coconuts	19,400,000
6.	Maize	19,387,022
7.	Palm kernels	6,560,000
8.	Bananas	6,189,052
9.	Tropical fruit	3,147,488
10.	Rubber	3,040,400

Source: FAOSTAT.

* PhD Student, International PhD Programme in Agrobiodiversity, Scuola Superiore Sant'Anna, Pisa (Italy). E.mail: p.septiani@sssup.it

country's Gross Domestic Product (GDP). Although agriculture's share of the GDP has declined during decades, it still provides income for the majority of Indonesian as 45% of Indonesia workers are engaged in this sector. With its vast and abundant fertile soils, Indonesia plays an important role as major global key producer of a wide variety of agricultural tropical products (Table 1). Some 31 million hectares are under cultivation, with 35 to 40% of the cultivated land devoted to the production of export crops.

There are three main types of farming: smallholder farming which mostly cultivate staple crops like rice and maize and also horticultural crops; smallholder cash cropping which cultivate export commodities like coffee, cocoa and pepper; and large foreign-owned or privately owned estates which cultivate large scale of oil palm and rubber.

The majority of Indonesian farmers are smallholders. They are subsistence farmers cultivating small areas of land of less than 0.5 ha, particularly in Java, and this situation remained almost unchanged as today. The farming activities is operated and managed by a family and predominantly relies on family labor, including both men's and women's and even their children. Half of the country's population is living in rural areas. Family farming is the predominant activity in these areas, not only providing food for the nation but being also important for the socio-economic, environmental and cultural roles of Indonesia.

Java is predominant in the country's food production of crops like rice and maize despite the fact that the amount of land owned by each household in Java is much smaller than in the outer islands. The farm size in Java is about a quarter of

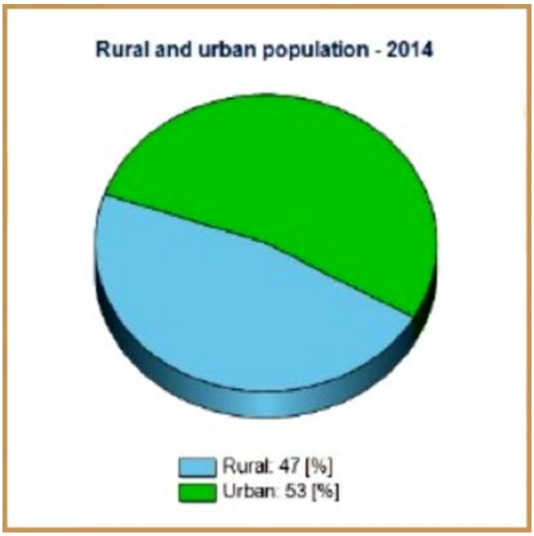

Fig. 1. Percentage of national population (Source: FAOSTAT).

a hectare or less per farm household, while in the outer islands like Sumatra, it is about one hectare or more for each farm household. Many native people in the outer islands own larger areas of land, which they have inherited from their ancestors.

In general, farming activities are still using traditional simple tools. For example, farmers use even a buffalo to plow the rice field or traditional instruments to harvest rice. Government programmes in agricultural mechanization has been executed since decades but slow technology penetration and implementation made farming activities with mechanization stagnant.

The Indonesian government has placed self-sufficiency in certain agricultural products high on its agenda and strategic planning, especially for rice which by far is the main staple food for the majority of the population. Indonesia has the highest per capita rice consumption in the world (approximately 139 kg per capita per year). However, the country is still dependent on imports from other neighboring countries like Vietnam and Thailand to secure its domestic rice supply. Government programmes are currently being executed and self-sufficiency in these food items should be reached. Since 2007 the government has also started revitalization programs for smallholding farmers in order to raise production but there are still many constrains that slow down this goal.

2. *Family farming in Indonesia: importance and challenges*

Despite the fact that family farming plays a vital role in national food production, there are many challenges encountered by farmers. As population increases every year, the need and demand of housing also significantly increases. In many rural areas where the land is used for rice fields, now it is common to find housing areas built by developers without proper planning, and certainly this land conversion has a direct impact on the low figures of rice production. On the other side, infrastructure limitation like poor access roads and ports have become the main constraint in transporting agricultural product from production areas to cities or to other provinces. In the case of horticultural products like vegetables, the long queues of trucks that transport products from one province to others can cause delays and further problems until the supply arrives at the delivery market.

Technology penetration and agricultural mechanization to support farming activities are always in the government agenda, but their slow implementation makes the value of technologies not well perceived by farmers. For example, not many farmers in rural areas are able to access the technology for maize threshing. Therefore, manual threshing becomes the only option for post-harvest handling, which is certainly less efficient.

Many environmental factors also contribute to the lower productivity in some areas and planting seasons. Associated with climate change, El Niño, a climate cycle in the Pacific Ocean with a global impact on weather patterns, have had a significant impact in lowering crop production, especially that of rice. Long periods of drought lead to crop failure in many rice production areas. A wide array of pests and diseases is also associated with climate change, which often lead to crop failure in many areas in certain seasons. Outbreak of certain pests and diseases can sometimes be predicted by accurate monitoring and mitigation of the previous outbreak and by the use of tolerant or resistant cultivars.

The availability of fertilizers and seeds of better quality at affordable prices is also important for the sustainability of family farming. Currently, government programmes subsidizing fertilizers and seeds purchase are being executed, but some regulatory burdens made these programmes low impact and even slow to be perceived by farmers.

To tackle all those challenges there should be strong commitment and effort from all sides, the government, industry, research institutions and the farming community itself, to work together to achieve the goal of sustainable agriculture systems in Indonesia, which is essential for family farmers to produce enough food for the nation.

3. *The Potential of Agrobiodiversity to Improve Family Farming in Indonesia*

The Convention on Biological Diversity (CBD) defines agrobiodiversity as all of the components of biological diversity relevant to food and agriculture, including agricultural ecosystems which include variety and variability of animals, plants and microorganisms at the genetic, species and ecosystem levels that are necessary to sustain agricultural production. One of the essential roles of agrobiodiversity in sustainable development is to provide the genetic resources or material for breeding new plant varieties.

Located on the equator with tropical climate, Indonesia has a wide array of pests and diseases which always become a problem for agricultural productivity throughout the year. In the case of pests and diseases outbreak, the use of resistant cultivars or varieties is considered to be the most effective control measure in Indonesian sustainable agricultural systems. Thus, breeding for resistance to pests and diseases was included as one of the main activities in breeding programmes, for example that aimed at developing rice cultivars resistant to Tungro diseases in rice farming in Indonesia since 1995 (Chancellor *et al.* 1999).

Agrobiodiversity playa an important role in providing genetic resources for better cultivars or varieties for sustainable family farming in Indonesia such as drought and disease resistant varieties to protect yield or to produce high-yielding varieties to improve the productivity of crops, which also has a direct impact to increase family farmers' welfare.

4. *The contribution of my PhD project*

Maize is the second major crop in Indonesia after rice, where it is mainly used for feed and food. Although the maize plantation area varies each year, the demand for maize as food and feed has been steadily increasing. However, the considerable production of maize in Indonesia is still far below the domestic demand, which caused a steady increase in its net imports since 1976.

The production system adopted by maize farmers in Indonesia depends on the geographical area, the cropping system, and management choices. The highest maize production is in Java Island, mainly in East Java province, as compared to other islands like Sumatra. Soil conditions in Java are considered the most fertile because of the large volcanic area. Farmers in Java can access irrigation, whilst in Sumatra the land is mainly rainfed. Drought conditions and low soil fertility are thus the limiting factors for maize production in the Sumatra area. Water supply is often a major farmers' concern in growing maize in certain seasons. Whilst in Java farmers are able to cultivate maize throughout the year or using a rice-maize rotation, in Sumatra farmers prefer to grow cassava in dry seasons. Besides environmental factors, the introduction of new hybrids and farmers practices might affect maize production in these areas (Swastika 2004).

Even when proper land management and irrigation are supplied, some of the major problems associated with maize production are posed by a wide array of diseases and pests known to attack maize plants throughout their life cycles and during storage (Baco *et al.* 2000). Especially in Java, downy mildew (DM) is perhaps the most important biotic stress affecting maize production. Cropping patterns such as maize grown after rice may lead to the outbreak of this disease. DM is caused by fungal pathogens of the *Peronoscleorospora* genus, and is becoming one of the most destructive systemic disease in maize cultivation in Indonesia. DM attack causes chlorotic stripes and/or overall yellowing on the leaf starting from the seedling stage. Early affected plants are stunted. Later, the growing maize tassels may be malformed and produce less pollen so that ears may be aborted and will not produce kernels. DM attack is a devastating disease that can cause up to 50-100% yield losses in susceptible cultivars. This disease can occur at any stage of maize development, from seedling to harvest. The DM affecting maize in Java and Sumatra islands is believed to be caused by *Peronosclerospora maydis*, which has been identified as the causal fungi of the destructive disease which may be observed in major maize production centers in East, Central, and West Java, South Sulawesi, Lampung, and North Sumatra. Metalaxyl fungicide is currently used to control this disease. However, the effectiveness of metalaxyl both as seed treatment and fungicide has sensibly declined with time. Resistant DM isolates to this chemical were observed at some locations (Septiani 2015, personal observation). This emerging problem supports the use of resistant varieties as cost-effective and environmentally safer alternatives to fungicides to control DM disease in maize.

The mapping of quantitative trait loci (QTL) makes feasible the detection, localization and characterization of genetic factors contributing the variation of poligenically inherited traits, including resistance to pathogens. QTL analysis allows researchers in fields as diverse as agriculture, evolution, and medicine to link complex phenotypes to specific chromosomal regions. The goal of this approach is to identify the action, interaction, number, and precise location of these causal regions (Miles and Wayne, 2008). QTL mapping linked to DM resistance traits can be used to develop maize line resistant through marker-assisted selection strategy or transformation technology. Studies on genetic DM resistance have been done in some Asian countries and QTL involved in resistance to important DM pathogens have been identified (George *et al.* 2003). A study employing association mapping also identified the association between 48 SSR markers and DM resistance using set of 60 public and private maize inbred lines in Thailand (Phumicai *et al.* 2012). However, none of these studies focused on the rampaging problem represented by DM in Indonesia, which is possibly caused by local-specific pathogens. At the same time, these studies suffer limited QTL mapping definition capacity caused by either sparse molecular markers or small and poorly diverse mapping panels. A multi parental mapping resource in maize may be of great relevance in identifying the molecular bases of DM resistance. The MAGIC maize (MM) population produced and available at the Scuola Superiore Sant'Anna is perhaps the most advanced QTL mapping tool in maize genetics available nowadays. With its superior diversity, contributed by eight diverse parental lines and its multiple generations of intercrossing, MM permits to identify QTL with a definition approaching the gene level (Dell'Acqua *et al.* 2015). This kind of definition and power is especially promising in mapping genes related to DM disease and other traits of interest in Indonesia and worldwide. Discoveries made with the MM can be transferred in commercial maize either by introgression or by transformation, sensibly speeding up the improvement of maize cultivations in Indonesia.

LITERATURE CITED

Baco, D., J. Tandiabang, and W. Wakman (2000). Pests and Diseases of Maize in Indonesia: Status and Research Needs. In Vasal *et al.* (eds), Proceedings of the Seventh Asian Regional Maize Workshop PCARRD, Los Banos, Philippines, February 23-27, 1998.

Chancellor T.C.B., Azzam O., Heong K.L., eds. (1999). Rice tungro disease management. Proceedings of the lnternational Workshop on Tungro Disease Management, 9-11 November 1998, IRRI, Los Baños, Laguna, Philippines. Makati City (Philippines): International Rice Research Institute. 166 p.

Dell'Acqua M., Gatti D.M., Pea G., Cattonaro F., Coppens F., Magris G., *et al.* (2015). Genetic properties of the MAGIC maize population: a new platform for high definition QTL mapping in Zea mays. *Genome Biol* 16: 167.

FAOSTAT. http://faostat3.fao.org/home/E, accessed on December 9th, 2015.

George M.L.C., Prasanna B.M., Rathore R.S., Setty T.A.S., Kasim F., Azrai M., Vasal S., Balla O., Hautea D., Canama A., Regalado E., Vargas M., Khairallah M., Jeffers D., Hoisington D. (2003). Identification of QTLs Conferring Resistance to Downy Mildew of maize in Asia. Theor Appl Genet 107: 544-551.

Miles C. & Wayne M. (2008). Quantitative trait locus (QTL) analysis. *Nature Education* 1: 208.

Pumichai C., Chunwongse J., Jampatong S., Grudloyma P., Pulam T., Doungchan W., Wongkaew A., Kongsiri N. (2012). Detection and integration of gene mapping of downy mildew resistance in maize inbred lines though linkage and association. *Euphytica* 187: 369-379.

Swastika, D.K.S., F. Kasim, K. Suhariyanto, W. Sudana, R. Hendayana, R.V. Gerpacio, and P.L. Pingali (2004). Maize in Indonesia: Production Systems, Constraints, and Research Priorities. Mexico, D.F.: CIMMYT.